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Improving Surface Cleaning and Hand Hygiene Using Fluorescent Markers

Taryn Whitman
tmwhitman@dons.usfca.edu

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University of San Francisco

School of Nursing and Health Professions

Contents

Abstract

Problem: Compared to inpatient units, ambulatory care clinics have differences in staffing available and frequency to perform room turnover (RTO). Pre-intervention data revealed poor Hand hygiene (HH) and high-touch surface cleaning (HTSC) knowledge and low RTO compliance reliability. Currently, there is no process for objectively monitoring RTO compliance and staff self-evaluation of HH, HTSC, and RTO performance is incongruent with observations.

Context: HH and HTSC are a crucial component of preventing healthcare-associated infections (HAIs). Estimated loss of revenue for one northern California tertiary university hospital system (HCO) campus was nearly $1.8 million dollars in Medicare penalties for 2018.

Intervention: This project used fluorescent marker and provided performance feedback and education to staff on HH and HTSC that was specific to their clinic. Clinic leadership implemented the use of the checklist tool within their clinics. Planned interventions are also described.

Measures: HH scores, HTSC scores, and staff self-perceived performance on HH, RTO, and HTSC were averaged and measured for significant change. Percentage of surfaces cleaned adequately by end of shift were tallied (surfaces cleaned / surfaces inoculated).

Results: Significant improvement was observed in HH knowledge from baseline. HTSC knowledge improvement was not significant. Self-evaluation of HH, RTO, and HTSC was not significantly changed compared to baseline.

Conclusions: Clinic-specific education on HH, RTO, and HTSC may improve compliance to HCO guidelines and reduce HAIs. Self-evaluation of HH, RTO, and HTSC performance is incongruent with observations, suggesting the need to have internal or external compliance monitoring.

Section II: Introduction

Healthcare-associated infections (HAIs) represent a significant economic burden to the U.S. healthcare system and threaten the safety of patients, staff, and the community (Khan & Baig, 2017). At a given time, it is estimated that 1 in 31 patients have at least one HAI (CDC, 2020). Since 2018, this northern California tertiary care university hospital system (HCO) has been annually penalized by Medicare for nationally scoring in the top 25th percentile for hospital-associated conditions, including HAIs, at an estimated cost for only one of their main campuses of $1.8 million dollars per year (Rau, 2020). A recent study evaluated the societal costs of HAIs to the U.S. healthcare system and reported that the estimated 200 billion per year far outweighs the direct hospital losses that are typically reported (Scott et al., 2019).

Quality improvement projects aimed at addressing the root causes of HAIs are valuable for improving the quality of care that is provided to their patient population and ultimately reduce the significant expenses associated with them (Mortimer et al., 2018). Studies that targeted improving hand hygiene or environmental cleaning compliance found significant and sustained reduction in HAIs of interest within their organizations (Anderson et al., 2017; McCalla et al., 2018; White et al., 2020). The Clinical Nurse Leader (CNL) is a masters-trained nurse with the skillset to assess gaps for delivery of safe and cost-effective healthcare at the microsystem level, making them a valuable asset to healthcare organizations in reaching their stated goals (Hoffman et al., 2020). By working at the microsystem level, CNLs are able to implement small tests of change and measure outcomes without barriers of needing significant resource allocation or infrastructure changes (Kaack et al., 2018).

Hand hygiene and environmental cleaning represent a critical component of HAI prevention measures. An estimated 40% of HAIs come from healthcare provider hands and high-touch surfaces (Suleyman et al., 2018). The HCO has highlighted their dedication to these

measures by setting a standard of 95% hand hygiene compliance and use of the “room ready” model to improve environmental cleaning reliability in their inpatient service (Henderson, 2015). In ambulatory clinics, the HCO has provided guidelines for room turnover, online and in-person training for hand hygiene and surface cleaning, and supplies for disinfecting surfaces and equipment.

Problem Description

Limitations exist for these goals in the associated ambulatory setting. Historically, ambulatory care lacked the resources and support that was common for inpatient care (Miller & Bringhurst, 2020). Differences in staffing place the majority of environmental cleaning on unlicensed assistants, such as medical assistants, and nursing staff. Custodial services are responsible for the floors, some bathrooms, and emptying trash bins, but cleaning of surfaces, equipment, and office space primarily falls to the clinic staff. Staff are expected to wear many hats, and this experience of having many responsibilities can cause the quality in performing these tasks to decline in an effort to prioritize their time (Hefzy et al., 2016). Adding to the issue, more demands on the staff for time may reflect the expansion of healthcare being delivered through ambulatory care. Since 2019, ambulatory care visits at the HCO have increased by 18%. With limited space being identified as a weakness of this HCO in a SWOT analysis (Table A3), the demand for service may place additional stress on staff for room turnover.

Ultimately, the prevention of HAIs through proper disinfection and hand hygiene may be negated due to unrecognized compliance issues. Staff may have insufficient knowledge and training to correctly performing hand hygiene and cleaning through the offerings of the HCO, as it is generalized and may not be correctly applied to their clinic. Monitoring of hand hygiene and environmental cleaning practices is therefore necessary to ensure that staff are meeting compliance goals with their currently available resources (Hefzy, 2016). The monitoring surveys

in place show the HCO is still falling below their goal of 95% compliance for HH. Hand hygiene survey data for participating clinics from February 2021 to April 2021 showed high compliance from internal observers (nearly 100%), but low compliance from external observers. This discrepancy may be caused by internal observer bias, observer presence influencing results (Hawthorne effect), or misunderstanding of hand hygiene policies by the observer. In-person observations of clinic rooms showed visible dust on some of the high-touch surfaces on the HCO room turnover list. The observations and data, taken together, suggest a significant compliance problem with available resources and policies.

Available Knowledge

The following PICO question was used as a guide for literature review and synthesis of the available evidence: In ambulatory clinics (P), will implementing an internal hand hygiene and surface cleaning bundle (I) improve compliance (O) compared to using available resources alone (C)? A review of the available literature was completed using Google Scholar, PubMed, and Cochrane Reviews databases. The databases were searched using key terms related to the topic, and included: surface cleaning, high-touch surface, room turnover, outpatient care, ambulatory care, fluorescent marker, GloGerm, objective monitoring, hand hygiene, compliance, healthcare-associated infections, and infection prevention. Limitations were set to only include English peer-reviewed studies published after 2012.

Draper et al. (2020) described the specific barriers that outpatient care faces in surface cleaning compliance due to high room turnover and cleaning responsibilities falling primarily on medical assistants. Lapses in infection prevention may still be significantly under-reported in ambulatory care (Sood & Leekha, 2018). With under-reporting and poor compliance to infection prevention measures, HAI risk may be higher than data shows. Many studies demonstrated that environmental cleaning and hand hygiene compliance was directly correlated with reducing

HAIs (Everett et al., 2017; Ragusa et al., 2018; Daniels et al., 2019; Furlan et al., 2019; Branch & Amiri, 2020; Meyer et al., 2021). Additionally, targeting high-touch surface areas instead of full room cleaning showed a greater reduction in HAIs (Everett, et al., 2017; Reynolds et al., 2018). Using objective monitoring is a crucial intervention for ensuring compliance and to standardize the evaluation for observers (Abosi et al., 2019; McGarity & Salgado, 2019; Rawlinson et al., 2020). Objective monitoring revealed that staff were most consistently cleaning items in the room that they perceived as dirtiest (Rawlinson et al., 2020). In one review, healthcare workers reported that compliance with infection prevention policies, including cleaning, hand hygiene, and use of PPE was influenced by their fear for personal safety and the support they received from management (White et al., 2020).

The CDC has outlined methods for evaluating the cleanliness of surfaces, including visual inspection, microbiological, ATP, and fluorescent markers (Rutala & Weber, 2019). Visual inspection is fast and inexpensive but is not reliable for estimating cleanliness. Microbiological sampling is considered a gold standard but is labor intensive, has slow turnaround, and requires appropriate staff and infrastructure. ATP testing is widely used in several fields to detect bioburden, but requires setting a threshold, is susceptible to testing technique, and has been reported less reliable for cleanliness than fluorescent markers (dos Santos et al., 2017; Hung et al., 2018; Burnham et al., 2020). The widespread use of fluorescent markers and the measured impact it had on improving environmental cleaning outcomes demonstrates its feasibility for use in outpatient care (Sridhar et al., 2018; Furlan et al., 2019; Draper et al. 2020). In use for covert evaluation of cleanliness, the CDC warns that the gel product is the least visible and less likely to be detected and targeted by cleaning staff. Some studies found that cleaning staff would circumvent the monitoring by carrying blacklights and identifying inoculated surfaces for targeted cleaning; this has been suggested as a reason for discrepancies between fluorescent

marker removal and ATP testing (Carling, 2016). Other studies have used the powder form to evaluate cleaning and cross-contamination, identifying targets for cleaning that were appropriate for their workspace. As a visual aid, photos of missed or transferred fluorescent marker was included in staff education with significant impact. Several investigators saw improvement in hand hygiene and surface cleaning compliance that was sustained for many months (Wiles et al., 2015; Southwick et al., 2017; White, 2020). Lastly, educational interventions to individually evaluate the hand hygiene and surface cleaning performance using fluorescent marker provides individual instant feedback on technique and is valuable for identifying individuals who previously had unidentified gaps in their training (Wiles et al., 2015; Kwon et al., 2020).

Outside monitoring has the benefit of being unbiased, standardized, and linked to resources that may help address identified issues. Limitations of outside monitoring include the Hawthorne effect of staff performance under observation, unfamiliarity with clinic operations and environment use, and limited staff available to perform regular monitoring. Internal monitoring demonstrates risk of bias, but this bias may be avoided by training the observer in the importance of standardized monitoring. By utilizing a clinic staff leader, monitoring can be performed by a person who has a vested interest to keep compliance high, lowering the risk of an HAI being acquired from their own work environment (Carling, 2016; Furlan, 2019).

Taken together, the evidence reviewed supported that surface cleaning and hand hygiene may improve with the addition of easily implemented covert fluorescent marker monitoring, instant feedback, and regular compliance knowledge testing that is specific to providing care in their clinic. A microsystem assessment (Table A4) and a study of related processes (Figure B2) allowed for adaptations to inpatient setting bundles to make them appropriate for use in the ambulatory care environment. The improvement can be sustained through scheduled ongoing internal fluorescent marker monitoring with feedback. New high-touch surface areas can be

identified and subsequently included on cleaning checklists. To avoid detection, fluorescent marker should be applied before clinical hours to high-touch surface areas and tallied for percent missed by end of the shift. Rather than small dots that could be targeted, small amounts of fluorescent powder should be placed with broad strokes onto target surfaces, ensuring that only cleaning the entire surface area removes marker. Individual feedback on performance of a mock room turnover can identify areas to target for improvement and collectively data can be used to inform on trends for different professions and different specialties.

Rationale

In 2009, Kishore argued that visual aids and other types of multimodal learning strategies can help improve the learning experience and increase the impact of the education (White et al., 2020). GloGerm and similar products are widely used in education exercises because they provide a visual simulation of things that are often not visible, such as hand or surface contamination (Abosi et al., 2019; Rawlinson et al., 2020). The theory of planned behavior also informs us that a strong motivator for performing hand hygiene and cleaning is fear for personal safety or the safety of others (White et al., 2020). If staff can visualize simulated contamination on high-touch surface areas, their following performance may improve significantly. The Hawthorne effect describes an influence over behavior in the observed from the presence of the observer. By covertly placing fluorescent marker, observers can appreciate cleaning practices that are representative of a typical clinical day. Accurate representation of cleaning performance is necessary to plan interventions (Carling, 2016). Bandura's social learning theory argues that people learn from imitating and learning behaviors from those around them, and in the context of clinical practice, new and entry-level employees will learn and emulate those that they work closely with. As medical assistants and nurses practice closely with their clinical managers daily,

an internal monitoring with feedback from immediate supervisors stands to offer more benefit to improving performance than infrequent external interventions (Kilinç et al., 2017).

Specific Aim

The specific aim of this fluorescent marker project is to improve percent cleaned high-touch surfaces to 50% or higher by April 2021. The second aim of this project is to increase hand hygiene and surface cleaning knowledge to 80% or higher by April 2021.

Section III: Methods

Cost Benefit Analysis

The cost to implement this project includes labor, fluorescent marker materials, and cleaning supplies (Table A2). For the purpose of ongoing internal monitoring, an estimated 1 hour of labor (median ambulatory clinical managers earnings of $181,000 at $95.00/hour) is needed per month to place glogerm before clinical hours and collect tallies for scoring at end of day ($1,140). Glogerm powder and blacklight kits can be purchased for $32.00 and will be sufficient to monitor for the year. Cotton tipped applicators are needed to inoculate surfaces (1 applicator per high-touch surface) at $6.00 for 1000, an estimated $12.00 annually. While cleaning supplies and PPE are included in the operational budget for covert monitoring as they are part of the room turnover process, individual training assessments are outside normal operations. One tube of wipes at $7.00 and one box of nitrile gloves at $6 each would be needed for this training. Individual trainings should be performed every 6 months by a nurse manager or nurse educator. Training is estimated to take 5 minutes for set up, 5 minutes for room turnover, and 10 minutes for review of performance with employee and reteaching. This training can include training for managers in the application and tallying of fluorescent markers on surfaces as needed. For a clinic with 5 staff responsible for cleaning, the labor cost would include 100 minutes of educator labor ($158.00) and 100 minutes of staff time, which may vary based on

profession mix, but is estimated between $216.00 and $345.00. The total estimated cost to perform monthly internal monitoring and biannual training sessions is $1700 per clinic.

Outside the significant risk COVID-19 represents for nosocomial infections, HAIs represent a significant cost to the HCO. Of those HAI reported, the HCO was penalized an estimated $1.8 million in 2020 for one campus (Rau, 2020). The benefit of increased environmental cleaning and hand hygiene has been demonstrated in many environments, with a decrease in some HAIs up to 100%. With 2,265,310 outpatient visits for 2020 and a HAI rate that does not differ from national benchmarks of 1 in 31 patients, 73,000 ambulatory patients could have acquired an infection during their visit. Taken with the penalties of 1%-3% lost from Medicare, revenue losses could easily be estimated at 190 million dollars annually. The total estimated savings from preventing even one HAI on ambulatory unit is estimated between $2600 to $6600 depending on the infection (Rinke et al., 2020), which covers the cost of the intervention for one year. One 250-bed multi-hospital cleaning bundle, which parallels interventions proposed here, was implemented and reported to have saved the organization $1.24 million annually (White et al. 2020).

Intervention

Baseline Performance Assessment

The hand hygiene and surface cleaning intervention was planned to be implemented as follows: ambulatory clinic leadership is contacted by educators and the purpose of the project is discussed. The importance of staff being unaware of the initial fluorescent marker placement is emphasized. The clinic manager identifies areas and equipment within the clinic and their use. A day for fluorescent marker placement is arranged and the clinic manager joins the educator to learn appropriate placement on high-touch surfaces and scoring (Figure B3). The fluorescent marker is placed with cotton applicators to create thin broad strokes that are invisible to the

naked eye but clearly visible under blacklight. The clinic manager shares the self-evaluation survey and knowledge test questions with staff to be performed before fluorescent marker placement day 1.

Clinic-specific Training and Education Interventions

At end of clinical day, educator and clinic manager tally and photograph results under blacklight. The data and photographs are included in an asynchronous education module that highlights targets for improvement and provides visual aid examples of satisfactory cleaning, partial cleaning, and misses. Special misses, transfers from contaminated hands, or trends that are specific to the clinic will be emphasized. Knowledge of appropriate hand hygiene and cleaning will be tested again for significant improvement. The clinic manager will share the post-day-one self-evaluation survey with staff and decide on internal interventions to improve performance. A checklist for surfaces that should be cleaned with each room turnover will be provided to the clinic. The educator will schedule a training day with staff where room turnover is evaluated individually for staff responsible for cleaning. Fluorescent marker will be placed in broad strokes on high-touch areas in an unused room. Staff will be asked to perform room turnover using their normal PPE and cleaning products. Staff will also apply fluorescent marker to their hands and demonstrate appropriate hand hygiene. Instant feedback will be provided privately.

Checklist Intervention

During the intervention phase (2-3 weeks), staff will use the provided checklist, which should be updated as needed, to perform room turnover. The checklist will provide feedback to the manager for the amount of time needed to perform appropriate cleaning for different visit types, and adjustments to scheduling or staffing can be made as deemed necessary. The checklist will also provide accountability for room turnover and ensures that room turnover performance is

verified by the employee. Tallied room turnover slips should roughly match the number of patient visits for the day.

Manager-led Internal Monitoring

The nurse educator will schedule and second run day with the clinical manager for fluorescent marker placement. The manager will demonstrate proper technique for application and tallying to surfaces listed on the most recent room turnover checklist. Data of performance will be discussed with the clinic staff and targets for improvement will be identified. The manager will purchase fluorescent marker for the clinic and perform monitoring on a recurring randomized schedule, approximately once a month. Performance data will be collected using online surveys that are accessible to educator. This allows the educator to maintain observations on intervention outcomes and follow-up with managers that are not performing monitoring at least once a month.

Study of Intervention

The intervention was only partially implemented (baseline performance assessment, education module, pre-intervention survey, post-education survey, and checklist). During the intervention process, implementation was reviewed daily with the ambulatory clinical services nurse educator and involved frequent correspondence and discussion with clinic managers. A Plan-Do-Study-Act (PDSA) cycle (Figure B1) was performed after each clinic fluorescent marker placement and data collection run. Using this method allowed the intervention team to evaluate the current data and determine if changes were needed for future runs to meet expected outcomes and measure performance. The first PDSA cycle revealed that collecting tallies before collecting photographs allows the observer to fully appreciate trends in performance and identify representative examples (i.e., a door that shows missed cleaning and evidence of touching) for photographs to reduce the number of photographs that need to be taken, significantly reducing

the time needed to collect data at end of day. A second PDSA cycle showed that providing feedback on the number of survey responses received allows managers to follow up with staff that had not yet completed it, increasing participation.

Measures

The hand hygiene and surface cleaning project was designed with simple measures in mind that would allow for ongoing internal monitoring. Many examples of surface cleaning monitoring programs demonstrated the feasibility of tallying surface categories with yes or no to collect an average mean (Abosi et al., 2019). Figure B3 demonstrates the following:

Fluorescent Marker Measuring

For each room, the observer can choose "yes" to note whether the surface was completely cleaned, characterized by:

1. Complete removal of fluorescent marker;
2. Almost complete removal, with small (less than 1 cm) areas missed on a surface or residual fluorescent marker in large areas that show pattern representative of wiping with a disinfectant wipe (streak and water spot pattern).

The observer can choose "no" to note whether the surface was partially cleaned, missed, or showing signs of recontamination, characterized by:

1. Surface shows signs of incomplete cleaning with large (greater than 1 cm) areas not showing signs of wiping. Common misses include the sides or undersides of objects.
2. Surface shows no signs of wiping on any part of the object. May show signs of hand impressions, fingerprints, scratches, or other forms of disturbance but no observed pattern reflective of wiping or cleaning.
3. Surface shows signs of hand impressions, fingerprints, or other impressions that represent transfer from one contaminated surface (likely hand) to a surface that was not

inoculated or was inoculated, cleaned, then reinoculated. Reinoculated surfaces look like cleaned surfaces except for aberrant smudges resting on top.

Staff Self-Evaluation and Knowledge Surveys

Managers provide the online surveys to their staff that can be accessed through work or personal devices for convenience. All data is anonymous and only collects the demographic of profession to distinguish between anticipating knowledge base, potential skillset, and role expectations within the clinic. Self-evaluation surveys are formatted in a 10-item linear numeric scale and asked the participant to self-evaluate performance on their compliance with hand hygiene when it is required, whether high-touch surfaces are adequately cleaned in the clinic, and whether patient rooms are adequately cleaned between visits. Knowledge surveys included a question about timing for hand hygiene and dwell time for the product used on surface cleaning. Significance between baseline and post-education results was determined using a student T-test.

Checklist Use

Staff are supplied checklist to note start time of room turnover and end time of room turnover. This data was used to determine the average time for room turnover, but primarily serves the purpose of internal use. An example application of such would be to schedule 5 minutes for room turnover after a follow-up exam versus 20 minutes for room turnover after an excision.

Ethical Considerations

The hand hygiene and surface cleaning project was designed to supplement existing infection prevention measures offered by the HCO in order to accommodate the wide variability in services, staffing, and environment that specialty ambulatory care requires. By building on this universal set of recommendations, clinics can perform better in the measures that have been shown to improve the quality of patient care that is delivered. Providing a safe environment for

patients to receive care is part of the core nursing ethics outlined by the American Nurses Association (Mitchell et al., 2021). If compliance can be improved through implementation of this bundle, the HCO will be closer to meeting its set standards of care and save significant costs in the process. This project was reviewed and approved by the University of San Francisco; It is characterized as a quality improvement project based on evidence and therefore does not require an IRB approval (Table A5).

Section IV: Results

This project was aimed at improving compliance with hand hygiene and surface cleaning within the context of ambulatory specialty clinics associated with the HCO. Results from portions of the project that were completed demonstrated both expected and unexpected outcomes.

Fluorescent Marker Outcomes

The goal for this project was to improve percent cleaned high-touch surfaces to 50% by April 2021. Only the baseline evaluation portion of the fluorescent marker intervention was able to be performed and a total average across all participating clinics showed 17% surfaces cleaned by end of day (Table A1). Lowest performing (<10%) surfaces include stands or carts, cupboards, supply or emergency carts, large devices (i.e. scales or ultrasound), and small devices (exam chair controls, medication scanners). Surfaces that performed between 10% and 20% include the sink and fixtures, the door, the light switch, the blood pressure station (including the arm cuff, cords, thermometer, and interface), computer stations, and other (which was exclusively patient pillows for these clinics). Surfaces that performed 20% or better included the patient exam table, countertops, exam lights, extra chairs, and telephones. Transfers were observed to door handles, computer stations, and light switches.

Self-Evaluation and Knowledge Surveys

Gains in Hand Hygiene and Surface Cleaning Knowledge

A second specific aim of this project was to improve staff knowledge of hand hygiene and surface cleaning as it pertains to their environment. As part of the baseline assessment, staff were asked a question about hand hygiene timing and surface cleaning product dwell time. The baseline score for hand hygiene timing was 30% for all clinics. The baseline score for surface cleaning dwell time was 82%. Staff were evaluated using the same hand hygiene and surface

cleaning questions after the asynchronous education module. Post-education scores were 83% for hand hygiene with a significant improvement of 53% from baseline ($p<0.0002$). Post-education scores for surface cleaning were 96% with an improvement of 14% that was not significant ($p=0.13$).

Changes in Self-Evaluation Surveys

Staff were asked to rate on a linear numeric scale (1 to 10, with 1 being strongly disagree and 10 being strongly agree) their estimation of how well they performed hand hygiene when required, whether patient rooms are adequately cleaned between visits, and whether high-touch surface are adequately cleaned in the clinic. Pre-intervention scores for hand hygiene (HH), room turnover (RTO), and high-touch surface cleaning (HTSC) were 100%, 94%, and 92%, respectively. Post-education surveys scores for HH, RTO, and HTSC were not significant at 100% (no change), 90% ($p=0.46$), and 87% ($p=0.31$), respectively.

Section V: Discussion

Implementation for this project's first segment was simple and required one clinical day to gather baseline fluorescent marker data. The ease of generating this data as a jumping point for participating clinics creates confidence for its potential on a larger scale. The fluorescent marker was placed precisely on high-touch surface areas in 5 exam rooms before clinical days after first inspecting for unrelated fluorescence on surfaces under blacklight. Simple linear broad strokes created a distinct look that allowed for disturbances during tallying and photo collection at the end of day to be easily recognized. Of the surfaces evaluated, almost all high-touch surfaces showed some sort of contact by end of day. Baseline surface cleaning average of 17% was expected and reflected a pre-intervention score range common for projects using similar methods (Sridhar et al., 2018; Furlan et al., 2019; Draper et al., 2020). Surfaces that were most reliably cleaned were those that regularly have direct person contact, such as the exam table, guest chairs, and counters used for patient procedures. Surfaces that scored the lowest were stands, carts, large devices, and small handheld devices. Many of these surfaces were stored in the hallway and may not be included as part of normal room turnover. While the evaluation of surface cleaning could not be tallied during the planned second run, many similar studies demonstrated that an improvement of 90%+ average surface cleaning could be attained and sustained.

Knowledge questions were developed with the help of the ambulatory clinical services nurse educator. While additional questions would have allowed for a more comprehensive evaluation of staff knowledge, participation in projects could be adversely affected with increased time needed for the participation. Knowledge of appropriate hand hygiene can be complex in this environment. The education module included a simple phrase that may have contributed to the outcome: "Remember 30 seconds or 30 feet/New Zone". Staff were taught to perform hand hygiene within 30 seconds before or after crossing a door threshold, after walking

30 feet, or after entering a new zone. As gloves had been observed being worn by staff outside clinical rooms to retrieve patients from the waiting room, the education module reminded them of glove use policies as it pertained to them. Hand hygiene knowledge increased by 53% from baseline and may reflect better hand hygiene adherence in future hand hygiene surveys. Knowledge of appropriate dwell time was already at 82% at baseline, as a result, the improvement of 14% was not significant. However, this result may reflect the efficacy of another HCO initiative that assesses staff knowledge of this same question. Adequate knowledge and training in the use of the products available for surface disinfection is important and can significantly affect their efficacy.

Self-evaluation surveys were meant to inform on participant perspectives before seeing data and visual aids and compare those to any measured changes after the education module. Averaged self-evaluation scores were over 90% for HH, RTO, and HTSC questions. Staff were given data and photos demonstrating a low compliance for surface cleaning and cross-contamination onto other surfaces; despite this, self-evaluation did not significantly change, and self-evaluation scores even increased in the medical assistant group. This outcome suggested that objective monitoring is necessary and should be performed by personnel that are not directly responsible for surface cleaning, such as a clinic manager.

Conclusion

The potential benefits that hand hygiene and surface cleaning bundles hold for the ambulatory setting is promising. Directed efforts in this arena that combine education, tools such as checklists, and objective monitoring have demonstrated a sustained measurable benefit to many other organizations. Although this project was delayed pending consultation from other departments, it features key qualities that make it an excellent fit for improving ambulatory hand hygiene and surface cleaning goals. First, monitoring is objective and uncomplicated. The

scoring is simple to interpret and is meant to help staff and managers identify targets for improvement. Unlike ATP sampling for bioburden, surfaces inoculated with fluorescent marker reliably reflect cleanliness and that surface cleaning is consistently being performed. Even a once daily cleaning of the surfaces that scored 0% would be expected to contribute to lowering HAI risk. Second, monitoring is put into the hands of the staff that know the clinic best, the nurse managers. Lastly, the intervention is easily sustained through use of affordable materials and customizable/updateable education tools. This customization and ability to adapt to future clinic needs makes it a practical approach for improving hand hygiene and surface cleaning. With a low entry for proficient use of the fluorescent marker, managers could maintain the monitoring program internally and even expand the application in ways that are suited to their clinics needs. Managers could covertly place fluorescent marker in between patient visits to gather more concise data without the Hawthorne effect of an outside observer. With ongoing maintenance, HAI data for the clinic could be compared to baseline and inform on the impact of the intervention. Ultimately, by partnering with ambulatory clinics and giving the leadership the tools to evaluate, train, and reinforce the HCO goals, the risk of HAIs may diminish and lend to the quality of care provided to the patient population.

References

Abosi, O. J., Salinas, J. L., Pottinger, J., Holley, S., Kukla, M., Dains, A., ... & Millard, B. (2019). Improving Environmental Disinfection through Objective Assessments at a Large Teaching Hospital. American Journal of Infection Control, 47(6), S19-S20.

Anderson, D. J., Chen, L. F., Weber, D. J., Moehring, R. W., Lewis, S. S., Triplett, P. F., ... & CDC Prevention Epicenters Program. (2017). Enhanced terminal room disinfection and acquisition and infection caused by multidrug-resistant organisms and Clostridium difficile (the Benefits of Enhanced Terminal Room Disinfection study): a cluster-randomised, multicentre, crossover study. The Lancet, 389(10071), 805-814.

Branch, R., & Amiri, A. (2020). Environmental Surface Hygiene in the OR: Strategies for Reducing the Transmission of Health Care–Associated Infections. AORN journal, 112(4), 327-342.

Burnham, J. P., Shives, E. R., Warren, D. K., Han, J. H., Babcock, H. M., & CDC Prevention Epicenters Program. (2020). Assessment of percent positive agreement between fluorescent marker and ATPase for environmental cleaning monitoring during sequential application in an intensive care unit. American journal of infection control, 48(4), 454-455.

Carling, P. C. (2016). Optimizing health care environmental hygiene. Infectious Disease Clinics, 30(3), 639-660.

Centers for Disease Control and Prevention. (2020, November 20). Healthcare Associated Infections Data Portal. Centers for Disease Control and Prevention. https://www.cdc.gov/hai/data/portal/index.html#:~:text=From%20the%20HAI%20HospitHo%20Prevalence,survey%20to%20have%20an%20HAI.

Daniels, T., Earlywine, M., & Breeding, V. (2019). Environmental services impact on healthcare–associated Clostridium difficile reduction. American journal of infection control, 47(4), 400-405.

Draper, L., Gschwend, T., Heller, A., & Pisney, L. (2020). Identifying Gaps in the Ambulatory Room Cleaning Process of an Academic Medical Hospital. American Journal of Infection Control, 48(8), S4.

dos Santos Junior, A. G., Ferreira, A. M., Rigotti, M. A., Furlan, M. C. R., da Silva Barcelos, L., & de Andrade, D. (2017). Correlation between cleaning/disinfection surface monitoring methods in primary health care. Journal of Nursing UFPE on line, 11(7), 2818-2825.

Everett, B. R., Sitton, J. T., & Wilson, M. (2017). Efficacy and cost-benefit analysis of a global environmental cleaning algorithm on hospital-acquired infection rates. Journal of patient safety, 13(4), 207-210.

Furlan, M. C. R., Ferreira, A. M., da Silva Barcelos, L., Rigotti, M. A., de Sousa, A. F. L., dos Santos Junior, A. G., ... & da Silva Barreto, M. (2019). Evaluation of disinfection of surfaces at an outpatient unit before and after an intervention program. BMC infectious diseases, 19(1), 1-8.

Hefzy, E. M., Wegdan, A. A., & Wahed, W. Y. A. (2016). Hospital outpatient clinics as a potential hazard for healthcare associated infections. Journal of infection and public health, 9(1), 88-97.

Henderson, C. (2015, November 4). Technology helps streamline patient room turnover. Health Facilities Management. https://www.hfmmagazine.com/articles/1802-technology-helps-streamline-patient-room-turnover?dcrPath=%2Ftemplatedata%2FHF_Common%2FNewsArticle%2Fdata%2FHFM%2FMagazine%2F2015%2FNov%2FAHE-perspective-improving-patient-room-

turnover&utm_source=twitter&utm_medium=social&utm_campaign=HFM.

Hoffmann, R. L., Battaglia, A., Perpetua, Z., Wojtaszek, K., & Campbell, G. (2020). The Clinical Nurse Leader and COVID-19: Leadership and quality at the point of care. *Journal of Professional Nursing*.

Hung, I. C., Chang, H. Y., Cheng, A., Chen, A. C., Ting, L., Chen, M. W., ... & Sheng, W. H. (2018). Application of a fluorescent marker with quantitative bioburden methods to assess cleanliness. Infection Control & Hospital Epidemiology, 39(11), 1296-1300.

Kaack, L., Bender, M., Finch, M., Borns, L., Grasham, K., Avolio, A., ... & Williams, M. (2018). A Clinical Nurse Leader (CNL) practice development model to support integration of the CNL role into microsystem care delivery. Journal of Professional Nursing, 34(1), 65-71.

Khan, H. A., Baig, F. K., & Mehboob, R. (2017). Nosocomial infections: Epidemiology, prevention, control and surveillance. Asian Pacific Journal of Tropical Biomedicine, 7(5), 478-482.

Kilinç, G., Yildiz, E., & Harmanci, P. (2018). Bandura's Social Learning and Role Model Theory in Nursing Education. Health sciences research in the globalizing world, 132.

Kwon, J. H., Reske, K., O'Neil, C. A., Cass, C., Seiler, S., Wallace, M. A., ... & CDC Prevention Epicenters Program. (2020). Assessment of antibiotic-resistant organism transmission among rooms of hospitalized patients, healthcare personnel, and the hospital environment utilizing surrogate markers and selective bacterial cultures. Infection Control & Hospital Epidemiology, 41(5), 539-546.

McCalla, S., Reilly, M., Thomas, R., McSpedon-Rai, D., McMahon, L. A., & Palumbo, M. (2018). An automated hand hygiene compliance system is associated with decreased rates

of health care-associated infections. American journal of infection control, 46(12), 1381-1386.

McGarity, A. L., & Salgado, C. (2019). Improving and sustaining environmental cleaning compliance in a large academic hospital using fluorescent targeting audits, education, and feedback. American Journal of Infection Control, 47(6), S20.

Meyer, J., Nippak, P., & Cumming, A. (2021). An evaluation of cleaning practices at a teaching hospital. American journal of infection control, 49(1), 40-43.

Miller, P., & Bringhurst, J. (2020). Ambulatory Staff as Infection Control Liaisons: An Untapped Resource. American Journal of Infection Control, 48(8), S23.

Mitchell, B. G., Russo, P. L., Kiernan, M., & Curryer, C. (2021). Nurses' and midwives' cleaning knowledge, attitudes and practices: An Australian study. Infection, disease & health, 26(1), 55-62.

Mortimer, F., Isherwood, J., Wilkinson, A., & Vaux, E. (2018). Sustainability in quality improvement: redefining value. Future healthcare journal, 5(2), 88.

Ragusa, R., Giorgianni, G., Lupo, L., Sciacca, A., Rametta, S., La Verde, M., ... & Marranzano, M. (2018). Healthcare-associated Clostridium difficile infection: role of correct hand hygiene in cross-infection control. Journal of preventive medicine and hygiene, 59(2), E145.

Rau, J. (2020, January 31). Several 'Best' U.S. Hospitals Penalized Over Too-High Rates of Infection, Injury. NPR. https://www.npr.org/sections/health-shots/2020/01/31/801350993/several-best-u-s-hospitals-penalized-over-too-high-rates-of-infection-injury#:~:text=Those%20penalized%20%22honor%20roll%22%20hospitals,Center%20in%20Manhattan%3B%20and%20the.

Rawlinson, S., Cloutman-Green, E., Asadi, F., & Ciric, L. (2020). Surface sampling within a pediatric ward—how multiple factors affect cleaning efficacy. American journal of infection control, 48(7), 740-745.

Reynolds, K. A., Sexton, J. D., Pivo, T., Humphrey, K., Leslie, R. A., & Gerba, C. P. (2019). Microbial transmission in an outpatient clinic and impact of an intervention with an ethanol-based disinfectant. American journal of infection control, 47(2), 128-132.

Rinke, M. L., Oyeku, S. O., Ford, W. J., Heo, M., Saiman, L., DeLaMora, P., ... & Bundy, D. G. (2020). Costs of ambulatory pediatric healthcare-associated infections: Central-line–associated bloodstream infection (CLABSIs), catheter-associated urinary tract infection (CAUTIs), and surgical site infections (SSIs). Infection Control & Hospital Epidemiology, 41(11), 1292-1297.

Rutala, W. A., & Weber, D. J. (2019). Best practices for disinfection of noncritical environmental surfaces and equipment in health care facilities: A bundle approach. American journal of infection control, 47, A96-A105.

Scott, R. D., 2nd, Culler, S. D., & Rask, K. J. (2019). Understanding the Economic Impact of Health Care-Associated Infections: A Cost Perspective Analysis. *Journal of infusion nursing : the official publication of the Infusion Nurses Society*, *42*(2), 61–69. https://doi.org/10.1097/NAN.0000000000000313

Sood, G., & Leekha, S. (2018). Controversies in Healthcare-Associated Infection Surveillance. In Infection Prevention (pp. 267-276). Springer, Cham.

Sridhar, S., Graham, M. B., Savage-Taft, S., Fangman, J., & Munoz-Price, L. S. (2018). Environmental Cleaning of Outpatient Exam Rooms: How Frequent is Enough?. infection control & hospital epidemiology, 39(1), 114-115.

Southwick, K., Gibbs, K., Quinn, M., Ostrowsky, B., Adams, E. H., & Saiman, L. (2017). Developing a Checklist to Identify and Manage MRSA Outbreaks in the Neonatal ICU using a Multi-Disciplinary Approach. In Open Forum Infectious Diseases (Vol. 4, No. Suppl 1, p. S642). Oxford University Press.

Suleyman, G., Alangaden, G., & Bardossy, A. C. (2018). The role of environmental contamination in the transmission of nosocomial pathogens and healthcare-associated infections. Current infectious disease reports, 20(6), 1-11.

White, N. M., Barnett, A. G., Hall, L., Mitchell, B. G., Farrington, A., Halton, K., ... & Graves, N. (2020). Cost-effectiveness of an environmental cleaning bundle for reducing healthcare-associated infections. Clinical Infectious Diseases, 70(12), 2461-2468.

Wiles, L. L., Roberts, C., & Schmidt, K. (2015). Keep it clean: a visual approach to reinforce hand hygiene compliance in the emergency department. Journal of Emergency Nursing, 41(2), 119-124.

Appendix A

Table A1. Averaged Surface Cleaning During Baseline Evaluation of Participating Specialty Ambulatory Clinics

Combined Tallies for Surface Cleaning During Baseline Evaluation of Three Participating Specialty Ambulatory Clinics				
Surface	Cleaned	Missed	Percent cleaned	Transfer
Exam table	6	10	38%	
Stand/cart	0	13	0%	
Sink / fixtures	3	15	17%	
Countertop	6	8	43%	
Cupboards	0	15	0%	
Door	3	17	15%	3
Light Switch	2	17	11%	1
Exam Light	3	11	21%	
BP station	1	8	11%	
Computer Station	4	16	20%	4
Supply / Emergency Cart	0	4	0%	
Large Devices	0	10	0%	
Small Devices	0	13	0%	
Extra Chairs	7	9	44%	
Telephone	4	7	36%	
Other	2	10	17%	
Average Percent Cleaned	17%			

Note. Combined Tallies for Surface Cleaning During Baseline Assessment of Three Participating Specialty Ambulatory Clinics. Surface column describes the high-touch surface that was inoculated. Cleaned column shows sum across three clinics of surfaces tallied as clean. Missed column shows sum across three clinics of surfaces tallied as missed. Percent cleaned column shows number of cleaned surfaces divided by total surfaces inoculated as a percentage. Transfer column shows number of observed transfers of fluorescent marker to other surfaces.

Table A2. Cost-Benefit Analysis

Estimated Costs	***Amount in US Dollars (2021)***	***Total***
Labor	*$1,652*	
Supplies	*$48*	*$1700*
Estimated Savings	*Amount in US Dollars (2021)*	*Total*
HAI treatment costs	*$2600+ per infection*	
Medicare penalties	*1-3% per case*	*$2600+*
Net Benefit for one prevented HAI		*$900+ per HAI*

Note. The costs were estimated and rounded up for median nurse hourly wage in the San Francisco bay area and education supplies on an online store. The lowest ambulatory HAI treatment cost was used for this analysis.

Table A3. SWOT Analysis

Strengths	**Weaknesses**
Expertise, Reputation, Infrastructure, Resources	Limited capacity, high room turnover, cleaning by MA/RN
Opportunities	**Threats**
Lower HAI, lower costs, improve patient care, improve staff safety	Financial burden of HAIs, harm of patient or staff, poor reputation

Note. This SWOT includes organization-wide and ambulatory-specific considerations that are of significance to the project.

Table A4. Microsystem Assessment Using 5 Ps

Category	Description
Purpose	Provide safe patient care by complying with hand hygiene and cleaning policy
Patients	Primary and specialty ambulatory care patients
Professionals	Providers, nurses, medical assistants, specialty technicians, administrative, managers
Processes	Staff receive training for hand hygiene and room turnover that is inadequate.
Patterns	Cleaning performance not monitored regularly. Staff has poor compliance for hand hygiene and cleaning.

Table A5. Evidence-Based Change Project Checklist

Project Title: Improving Surface Cleaning and Hand Hygiene Using Fluorescent Marker	YES	NO
The aim of the project is to improve the process or delivery of care with established/ accepted standards, or to implement evidence-based change. There is no intention of using the data for research purposes.	X	
The specific aim is to improve performance on a specific service or program and is a part of usual care. ALL participants will receive standard of care.	X	
The project is NOT designed to follow a research design, e.g., hypothesis testing or group comparison, randomization, control groups, prospective comparison groups, cross-sectional, case control). The project does NOT follow a protocol that overrides clinical decision-making.	X	
The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does NOT develop paradigms or untested methods or new untested standards.	X	
The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does NOT seek to test an intervention that is beyond current science and experience.	X	
The project is conducted by staff where the project will take place and involves staff who are working at an agency that has an agreement with USF SONHP.	X	
The project has NO funding from federal agencies or research-focused organizations and is not receiving funding for implementation research.	X	
The agency or clinical practice unit agrees that this is a project that will be implemented to improve the process or delivery of care, i.e., not a personal research project that is dependent upon the voluntary participation of colleagues, students and/ or patients.	X	
If there is an intent to, or possibility of publishing your work, you and supervising faculty and agency oversight committee are comfortable with the following statement in your methods section.	X	

Appendix B

Figure B1. PDSA Cycle

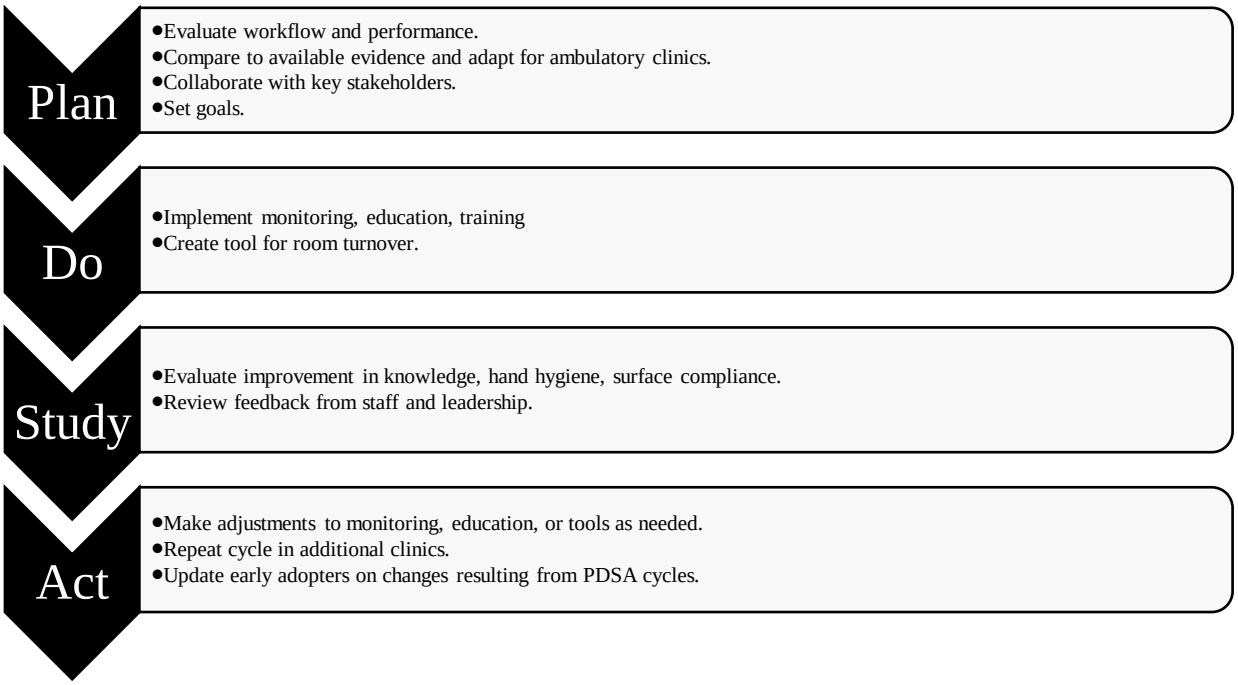
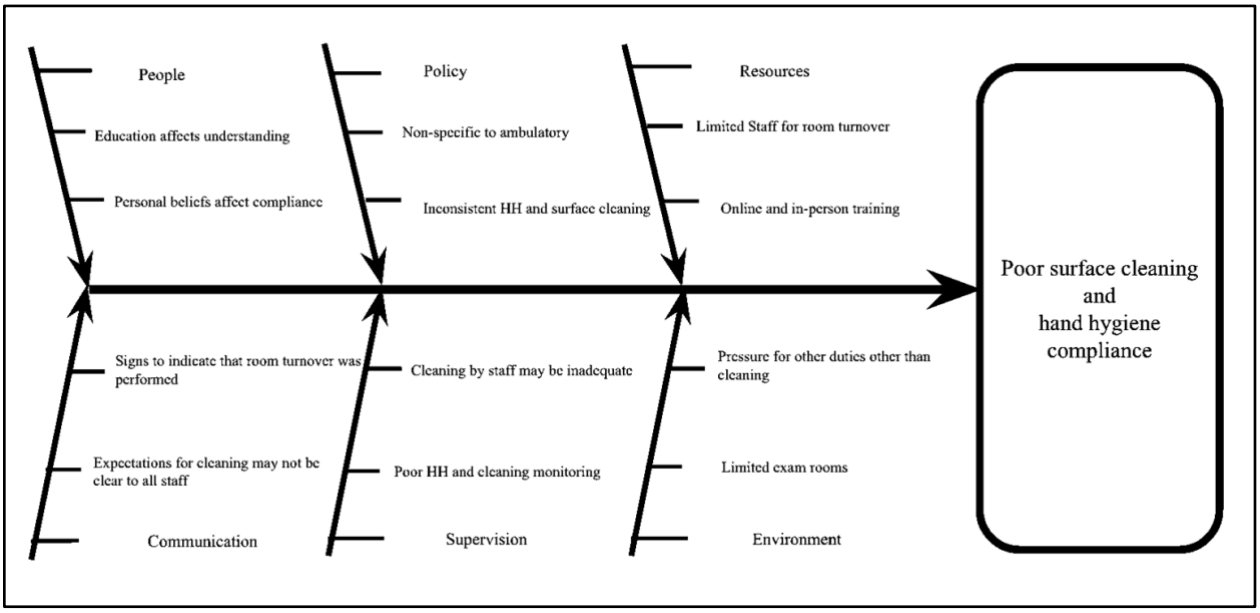


Figure B2. Fishbone Diagram for Clinical Processes



Note. Information was derived from clinic observations, survey data, and organization policies and training resources.

Figure B3. Fluorescent Marker Scoring Examples

Note: Examples of observations. (A) Surface miss. (B) Partial Clean (miss). (C) Surface clean.