Remote Video Auditing to Verify OR Cleaning: A Quality Improvement Project

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ABSTRACT

There are many sources of contamination in the perioperative environment. Patient experience can be negatively affected by the presence of environmental contamination, especially if it is the cause of a surgical site infection. Perioperative and environmental services staff members and leaders are tasked with ensuring a clean and safe environment for their patients while maintaining an awareness of time and budgetary constraints. In addition, leaders are responsible for the competency of their staff members and must address performance issues when needed. New technological advances designed to streamline monitoring and reporting processes related to OR cleanliness are available for use. This article describes the quality improvement project that one multifacility organization completed related to the use of remote video auditing and the positive effect it had on the organization's environmental contamination.

Key words: *contamination, environmental disinfection, quality improvement, remote video auditing, infection prevention.*

The incidence of health care–acquired infections (HAIs) in the United States resulting in illness and death is of significant concern. In a 2011 survey, Magill et al[1] estimated that approximately 721,800 HAIs occurred in an estimated 648,000 inpatients. Among the reported HAIs, pneumonia and surgical site infections (SSIs) were reported as the most common, followed by gastrointestinal infection, urinary tract infection, and primary bloodstream infection.[1] Surgical site infections depend on patient factors such as age, sex, underlying comorbidities, immunosuppression, and nutritional status; type of surgery (clean versus dirty); and length of the preoperative stay.[2,3] Extrinsic patient factors that can contribute to the development of an SSI include

- airborne and surface contaminants,[3,4]
- equipment in the OR contaminated by OR personnel hands,[5,6]
- contaminated instruments,[7]
- aerosols from water sources,[8,9] and
- airborne contaminants that settle on surfaces or fall into the incision site.[3,4,10,11]

The risk of SSIs can be reduced by controlling environmental contaminants; a one-year longitudinal study of inpatients who underwent a variety of surgical procedures among eight hospitals in Spain investigated the correlation between OR factors (eg, fungi and bacterial environmental contamination, temperature and humidity, air exchanges, air pressures), other factors, and SSIs. The aggregate SSI rate was 6.7% (1,267 out of 18,910 patients experienced an SSI); the researchers reported that when there were no contaminants in the OR, almost no SSIs were detected.[3]

The presence and amount of OR environmental microbes can alter the risk of an SSI.[3,8,10] Recommended practices for

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cleaning and disinfection are outlined in AORN's "Guideline for environmental cleaning,"[12] and researchers have reported a reduction in SSIs when appropriate cleaning and disinfection were included in their studies.[13,14] Perioperative and environmental services leaders are charged with ensuring that defined protocols are followed and that microbial contamination is reduced or completely eliminated.

Room surfaces are commonly assessed for surface contaminants after cleaning and disinfection.[15] Several types of audit tools assess the effect of environmental cleaning and disinfection; these include culturing and reporting colony-forming units (CFUs) of specific microorganisms, reporting adenosine triphosphate (ATP) levels using relative light units (RLUs), using fluorescent marking gel,[16] and observing and recording compliance with the cleaning protocol.[17] Perioperative and environmental services leaders can use audit tools and personnel resources to monitor the cleaning and disinfection protocol systematically, and sharing compliance feedback with perioperative and environmental services staff members can help improve and maintain adherence to the protocol.[17-19]

Remote video auditing (RVA) is another audit tool that can help verify cleaning practices and provide feedback about adherence to defined protocols to improve cleaning practice compliance. Evidence supports the use of RVA with feedback and has repeatedly indicated initial and sustained improvements in adherence to defined cleaning protocols.[17,20,21]

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DESCRIPTION OF THE PROBLEM

Environmental services staff members perform end-of-day OR cleaning and disinfection after the last procedure of the day either during the evening or night shift. In our facilities, environmental services staff members often independently complete multiple sequenced steps outlined by the facility's protocol, which aligns with the AORN "Guideline for environmental cleaning."[12] Perioperative personnel routinely visually inspect the work before the first procedure of the day; however, the environmental services supervisor or director only randomly inspects the work. When the perioperative environment does not appear to be clean, the environmental services supervisor or director is notified to follow up on the concern. The reasons that an OR might not pass a visual inspection may be known or unknown. Known reasons may include: assignment of an inexperienced team member to the perioperative area, inadequate staffing, which limits adequate time to clean the room, competing facility priorities, or a room that was missed in error.

Consistently observing and supervising all cleaning task steps in each OR is difficult. The measurement of adherence to end-of-day cleaning and disinfection procedures was limited at our facility because of the inability to supervise and observe all task steps in each OR consistently. Environmental services staff members work independently and are rarely provided with feedback on compliance when cleaning the OR. Perioperative, environmental services, and infection prevention leaders were aware of the importance of cleaning and disinfection in preventing SSIs, and realized there was a lack of available data regarding the end-of-day cleaning and disinfection. Therefore, these leaders, with the support of organizational leadership, decided to implement a quality improvement (QI) project regarding the verification of end-of-day cleaning by using RVA monitoring coupled with reporting of applicable data to perioperative and environmental services staff members.

SETTING AND PROJECT DESCRIPTION

Organizational leaders, in conjunction with perioperative, environmental services, and infection prevention leaders, conducted the QI initiative in two facilities in a 22-facility health system located in the northeastern United States. Facility 1 is a 252-bed community hospital with eight ORs, and Facility 2 is an 827-bed academic medical center with 23 ORs. The infection prevention leaders had noted documented SSIs after procedures, and perioperative nursing staff members had noticed that ORs were not always visually clean and ready to use at the beginning of the day. Perioperative, environmental services, and infection prevention leaders wanted to test the feasibility of RVA as an audit tool for end-of-day cleaning and disinfection in

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both hospitals and wanted to know whether implementing RVA and reporting its data would result in improved compliance with cleaning. The monitoring of end-of-day cleaning and disinfection was an effort to continue toward the organization's journey toward zero infections and manage controllable factors.

STATEMENT OF GOALS

The goal of this QI project was to identify and improve compliance with end-of-day cleaning and disinfection using RVA as a monitoring tool; the specific goal was to achieve and sustain a compliance rate greater than 95% for this project and as the anticipated standard after completion of this project. The steps toward this goal were to

1. collect baseline data on end-of-day cleaning compliance,
2. educate environmental services personnel regarding the importance of compliance with cleaning and disinfection protocols,
3. implement an RVA monitoring tool to assess compliance with cleaning protocols, and
4. report the data from RVA monitoring to pertinent personnel.

EVIDENCE REVIEW

Environmental contamination in the OR occurs, in part, as a result of inadvertent touching of items and surfaces with contaminated hands, and the use of sophisticated instruments and equipment that are difficult to disinfect adequately.[4-7] The need for detailed and thorough cleaning between procedures and at the end of the day has been identified as a solution to minimize perioperative environmental contamination for nearly 45 years.[22]

Link and colleagues[5] identified five primary high-touch surfaces in the OR: the anesthesia computer mouse, OR bed, nurse computer mouse, OR door to substerile area, and anesthesia medication cart. These sources were identified by counting the number of times each surface was touched by staff members' hands from the time the patient entered until he or she exited the OR. In addition to counting surface touches, these researchers cultured samples from areas of the OR before the first procedure of the day and used the post of the surgical light as a control. The results of these cultures quantified the degree of contamination:

- surgical light (post) – median 0.00 CFU/cm^2,
- nurse computer keyboard – median 0.47 CFU/cm^2,
- anesthesia computer mouse – median 0.26 CFU/cm^2,
- OR door push plate – median 0.22 CFU/cm^2,
- anesthesia medical cart drawer – median 0.09 CFU/cm^2, and
- OR bed – median 0.00 CFU/cm^2.[5]

In another study at a facility with six ORs, ATP was measured in RLUs after routine cleaning and before the patient was brought into the room.[6] All surfaces yielded bioburden, and the computer keyboard had the highest mean reading of 1810.8 RLUs.[6] Contamination occurs via multiple sources in the OR,[3,7,8,10] and guidelines for end-of-day cleaning and disinfection address these sources of contamination.[12]

Environmental cleaning and disinfection is complex and requires organized procedures designating specific personnel who are responsible for completing the work. An effective method for decreasing contaminants in the environment is applying a disinfection agent that remains in contact with the surface for a specified time.[23] Rutala and Weber[16] suggest the following strategies to improve the effectiveness of cleaning:

- selecting a disinfectant effective against the microorganisms that are the most common causes of health care–associated infections; and
- educating personnel on the defined protocols and the manufacturer's instructions for use of the disinfectant, including
    - contact time,
    - concentration,
    - compatibility with cleaning wipes and mops,
    - presence of sufficient moisture in the disinfectant to achieve adequate contact time, and
    - adherence to the defined protocols.

Using RVA, Pederson et al[17] audited an augmented perioperative room turnover protocol, finding that compliance increased despite additional steps in the protocol that increased turnover time. To increase the efficiency of cleaning and disinfection, this organization implemented a "pit crew" approach in which team members were assigned responsibilities during turnover. Shortly after RVA monitoring for turnover was initiated, compliance was 79%; after implementing the pit crew approach, average compliance

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rose to 93%. Monitoring end-of-day cleaning using RVA revealed an initial compliance of 67%; after review and additional educational sessions with environmental service personnel, the compliance rose to 94%. The facility experienced a 10% decrease in SSIs in the year after RVA was introduced compared with the previous year.[17]

Improving the cleanliness of the OR may be accomplished by supervising and providing feedback regarding the process of cleaning and disinfection.[17-19] In this QI initiative, our proposed solution was to use RVA and real-time feedback to assess compliance without feedback and use feedback combined with improvement strategies to increase compliance with end-of-day cleaning and disinfection.

Improving the cleanliness of the OR may be accomplished by supervising and providing feedback regarding the process of cleaning and disinfection.

PROJECT METHODOLOGY

Organizational, perioperative, environmental services, and infection prevention leaders decided to assess 11 essential elements on an end-of-day audit checklist of OR cleaning and disinfection practices and use RVA both without and with feedback given to perioperative and environmental services staff members. We submitted our proposed retrospective observational project to our organization's institutional review board and it was reviewed and approved. Low-resolution cameras were installed in each OR to provide a complete view of the OR to a third-party auditing company, Arrowsight Incorporated. Infection prevention and environmental services leaders and a representative from the third-party auditing company converted the cleaning protocol to an audit checklist consistent with AORN recommendations. The checklist listed the tasks that environmental service personnel were to perform during the end-of-day cleaning and the amount of time needed to perform those tasks.

Data Collection

At an external location, trained auditors from Arrowsight viewed streaming video of the activity in each OR. When the auditors observed the cleaning team conducting end-of-day cleaning, they recorded compliance of completion of the items on the checklist and the total duration of cleaning. The auditing process reported two timestamps, calculated the amount of time between the two timestamps, and assigned a pass or fail to the cleaning team depending on whether or not all requirements of the checklist were met. Tasks were scored as pass or fail and times for each end-of-day room cleaning were summed and then divided by the number of events; data were aggregated and then averaged for the referenced time period (eg, day, week, month).

Measurement Techniques

Remote observers working at Arrowsight's Network Operations Center in India are reviewed and assessed by higher level quality assurance personnel located in Arrowsight's Network Operations Center in Huntsville, Alabama. The review process requires that quality assurance personnel perform audits on 5% of the observed events in the project. Any remote observers in India who scored 97% or less are immediately removed from the auditing program and placed in remedial training. Upon successful completion of the training program, the remote observer returns to auditing under the direct supervision of a quality assurance auditor manager. Arrowsight requires any remote observer who scores less than 97% twice during a 30-day period to be removed from performing specific audits. During our evaluation period, no auditors scored at or below 97%.

Three audit periods for each facility were established: baseline, feedback, and maintenance with continued feedback. Baseline data were collected from March 18, 2013 to April 11, 2013 in Facility 1 and July 15, 2013 to October 14, 2013 in Facility 2. Feedback data were collected from April 15, 2013 to June 20, 2013 in Facility 1 and October 21, 2013 to March 13, 2014 in Facility 2. Maintenance period data for both facilities were collected during the 12 months after the end of the feedback audit. The maintenance period included the same feedback as within the feedback period, the only difference is that the QI project with involvement with organizational and infection prevention leaders was turned over to the perioperative and environmental service leaders to oversee and ensure continuance of high rates of compliance.

During the feedback period, appropriate personnel received education on the end-of-day cleaning processes

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and the results of the daily audits. The team sent daily (Figure 1) and weekly aggregate data via e-mail to perioperative and organizational leaders during the feedback period. The leadership teams responded to aggregate compliance rates by communicating compliance to personnel performing end-of-day cleaning, working with staff members to remove barriers to improve cleaning processes, acknowledging team success, coaching as needed, increasing communication among perioperative and environmental services personnel, redefining the cleaning protocol, providing ongoing education, and assigning accountability for the cleaning protocol to a single leader.

Table 1. Results of Remote Video Auditing to Verify Compliance With End-of-Day Cleaning Protocols

	Percent Compliance With Protocol (95% CI)	
Audit Period	Facility 1	Facility 2
Baseline	17.55 (10.28-24.81)	26.59 (15.63-37.54)
Feedback (first wk)	52.49 (34.27-70.73)	32.79 (26.64-38.94)
Feedback (overall)	98.09 (96.11-100.00)	87.56 (84.43-90.69)
Maintenance[a]	97.81 (97.21-98.41)	99.75 (99.69-99.80)

[a]Maintenance audit performed 12 months after feedback period was complete.
CI= confidence interval.

Data Analysis

Descriptive statistics comprising averages of the end-of-day cleaning checklist compliance and 95% confidence intervals were reported. An interrupted time series regression analysis was performed to measure the effect of the intervention in both facilities and significance was set at $P < .05$. Data were analyzed using STATA 14.0.

IMPLEMENTATION

We encountered multiple barriers while implementing this project. The end-of-day cleaning and disinfection protocol was not written in a sequenced protocol. The team members were informed of the cleaning process and their competency verified soon after hire. Because of the limited number of supervisors available for oversight, competency was validated sporadically after this initial onboarding. As a result, during the baseline audit, the auditors observed a lack of consistency in the way that team members performed the cleaning and disinfection process. To address the inconsistent practices, a sequenced protocol was agreed upon by environmental services, infection prevention, and perioperative services team members and converted into an audit checklist.

RESULTS

Table 1 shows the RVA data for Facility 1 and Facility 2 from the initial baseline audits, the feedback period

Report Name End-of-Day Cleaning Daily Dashboard Last Run Time: XX/XX/17 xx:xx:xx AM/PM
Date Sunday - XX/XX/17
Hospital Site Hospital A2

Room Number	EN1	EN2	LD1	LD2	OR01	OR02	OR03	OR04	OR05	OR06	OR07	OR08	OR09	Average %
Active Room Control Check	1	0	1	1	1	1	0	0	1	1	0	1	0	
Terminal Clean Count (for scoring)	1		1	1	1	1			1	1		1		
Actual Terminal Clean Count	1		1	1	1	1			1	1		1		
Terminal Clean - Personal Protective Equipment	Yes		Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Terminal Clean - Equipment Surface	Yes		Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Terminal Clean - Waste Baskets	Yes		Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Terminal Clean - Wall Wash			Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Floor Scrub 1st Half	Yes		Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Floor Scrub 2nd Half			Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Equipment Wheels	Yes		Yes	Yes	Yes	Yes			Yes	Yes		Yes		100.0%
Minimum Time Met	0		1	1	1	1			1	1		1		87.5%
Average %	83.3%		100.0%	100.0%	100.0%	100.0%			100.0%	100.0%		100.0%		**97.9%**
Number of Cleaners	1		1	1	2	2			2	2		2		

Room Number	EN1	LD1	LD2	OR01	OR02	OR05	OR06	OR08
Average Clean Time (in minutes)	12.4	83.1	77.6	50.6	45.9	51.9	43.5	49.4

Room Number Legend:
EN = Endoscopy Room
L&D = Labor and Delivery OR
OR = Operating Room

Figure 1. Remote video auditing dashboard showing daily aggregate room cleaning data.

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(during which feedback was provided to staff members and education and coaching occurred), and the maintenance audit. The final audit was performed approximately one year after the feedback period ended. In Facility 1, there was no meaningful increase in compliance per week during the baseline period. During the first week of the intervention feedback period, there was a significant increase in compliance over baseline ($P < .0001$), which increased further during the intervention period and was sustained over time.

In Facility 2, in the first week after the feedback intervention, there was a significant increase in compliance ($P < .0001$) that increased during the intervention period and was sustained over time. Figure 2 represents the changes in compliance during the baseline and feedback (ie, intervention) periods.

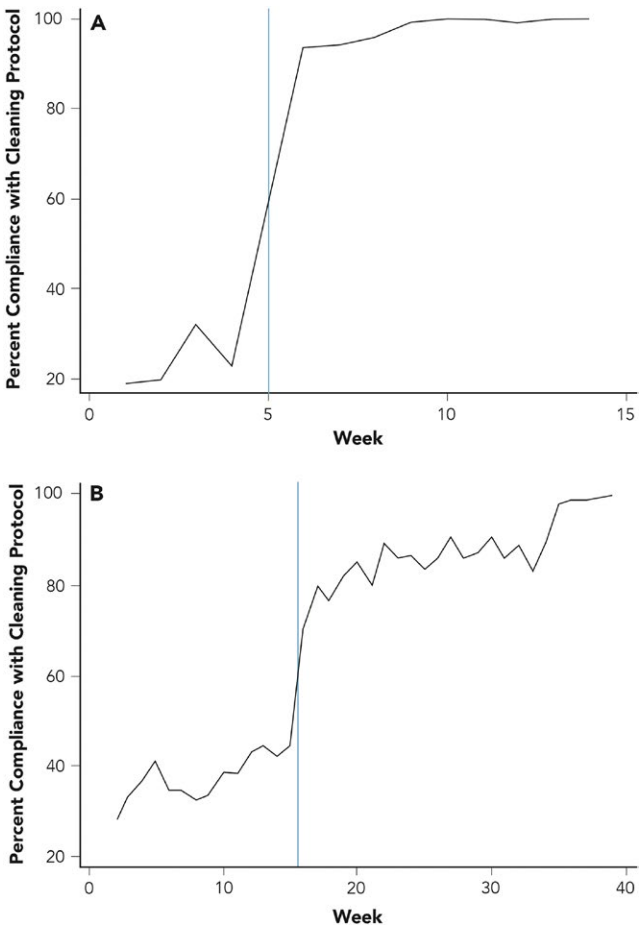

Figure 2. End-of-day cleaning compliance by week for baseline and feedback periods in Facility 1 *(A)* and Facility 2 *(B)*. Vertical line indicates the introduction of feedback.

DISCUSSION

After implementing this QI project, our organization found that RVA with feedback provides a reasonable approach to assess, improve, and maintain optimal cleaning and disinfection standards in the OR. Perioperative and environmental services leaders decided to expand use of RVA to in-between procedure cleaning. As a result of this project, our organization was able to

- define processes that outlined the physical actions and sequencing needed for the cleaning of both organic and inorganic material from all surfaces and equipment,
- educate multidisciplinary teams to ensure practice aligns with the defined process and is consistently repeated,
- provide support to ensure ongoing competency of defined practices, and
- develop a monitoring plan to ensure the ongoing assessment of compliance with the process.

The RVA data allowed for identifying procedural gaps with planned interventions for modification of protocols and ongoing audit data to assess for positive changes that hold individuals accountable for their work or the work they oversee.

The cost of implementing RVA for this project was approximately $25,000 per year for a community hospital with eight ORs to $50,000 per year for a tertiary hospital with 25 ORs. Our organization chose to use permanently installed cameras; however, it is possible to use a small number of high-resolution portable cameras that can be placed in desired areas to be monitored. The potential reduction in SSI rates could cover the cost of this service. Shepard and colleagues[24] estimated an approximate average cost difference in a patient with an SSI compared with a patient without an SSI to be $34,407. If two infections were eliminated during the course of a year, the cost of RVA with feedback would be cost neutral.

Increasing compliance with end-of-day cleaning helps minimize microbes in the environment and decrease the risk for surgical incision contamination contributing to an SSI. Although not the initial purpose of this study, SSI data from three years before to three years after the initiation of RVA with feedback were evaluated. Facility 1 reported a 14% decrease and Facility 2 reported a 2.5% increase in the SSI rate using data from the National Healthcare

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Key Takeaways

- Environmental contamination in the OR can increase the risk of patient infections.
- Evidence shows that improving the cleanliness of the OR may be accomplished by supervising personnel and providing feedback on cleanliness to the personnel and supervisors responsible for cleaning and disinfection.
- Several monitoring tools can assess the efficacy of OR cleaning. Remote video auditing (RVA) is an audit tool that can help verify cleaning practices and provide feedback about adherence to defined protocols to improve cleaning practice compliance.
- Leaders at a 22-facility health system located in the northeastern United States implemented a quality improvement project regarding the verification of end-of-day cleaning by using RVA monitoring coupled with reporting of applicable data to perioperative and environmental services staff members.
- Results of the project indicated that RVA with feedback provides a reasonable approach to assess, improve, and maintain optimal cleaning and disinfection standards in the OR. Creating a standard protocol for end-of-day cleaning and using RVA resulted in significantly higher compliance with standardized cleaning protocols for this organization.

Safety Network.[25] During the feedback period, Facility 2 experienced a change in surgical procedures because of a center of excellence designation for surgical oncology; the surgical population in the baseline versus the feedback period changed.

Strengths of the QI project include

- implementation in both a tertiary and community hospital setting,
- standardized cleaning and disinfection protocols, and
- feedback assessing each event using a standard checklist.

It is important to note that the cleaning team members, leaders, and auditors benefited from development of the protocol because it helped streamline the education, validation of competency, and auditing processes. The limitations included a lack of assessment of education and competency before the baseline period, no assessment of microbial contamination before and after cleaning and disinfection, and blurred camera views that inhibited detailed assessment of surface contact to assess cleaning and wet time of the disinfectant on the surface.

CONCLUSION

The OR environment has numerous microbial reservoirs that serve as the source and vector for disease transmission. Perioperative and environmental services staff members are crucial players in patient safety protocols, particularly regarding cleanliness of the OR. Our organization introduced the use of RVA and feedback of the audit data. Its use helped to promote defined cleaning and disinfection processes, increased personnel accountability for adhering to practices, provided immediate education based on observed practices, and provided data to motivate the multidisciplinary OR team. This initiative demonstrated that compliance with end-of-day cleaning was suboptimal. Monitoring with RVA combined with feedback produced a highly reliable and sustained improvement in end-of-day cleaning at two facilities in our organization.

The relationship between environmental contamination and SSI infection rates is well documented. Oversight of cleaning protocols is needed to improve environmental cleaning, and RVA with feedback provided that for our organization without the need for hiring additional managers. After this QI project, our organization has continued to use RVA with feedback for end-of-day cleaning and has expanded its use to between-procedure cleaning. Research to assess cleaning and disinfection using RVA that includes the reporting of SSIs should be considered to substantiate the value of RVA to audit cleaning in the OR.

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