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Concise Communication

Implementation of cleaning and evaluation process for mobile patient equipment using adenosine triphosphate

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Abstract

We implemented a cleaning process for mobile patient equipment (MPE) and determined its success using adenosine trisphosphate (ATP) monitoring and data feedback. Following education for staff and ATP data feedback, the data suggest that the MPE cleaning program we implemented was successful.

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Mobile patient equipment (MPE), such as blood pressure cuffs, thermometers, pulse oximeters and bladder scanners, are environmental surfaces that pose significant risk of infection to patients if not disinfected appropriately. Contaminated environmental surfaces can directly transmit multidrug-resistant organisms to patients, or they can travel on healthcare workers' hands.[1,2] These devices require low-level disinfection by cleaning with a quaternary disinfectant or bleach-containing cleanser between uses. Although the disinfection process of MPE is important for reducing the bacterial burden and the subsequent risk for healthcare-associated infections (HAIs), low-level disinfection of MPE can be difficult to effectively implement and monitor.[3,4]

Cleanliness of MPE can be assessed in various ways. Direct observations, a subjective evaluation, lack the ability to detect gross contamination. Fluorescent markers are widely reported in the literature,[5] but they have variable reliability and success. Environmental cultures are both resource and time intensive. Adenosine triphosphate (ATP) bioluminescence assays measure effectiveness of cleaning by detecting organic material on a surface in real time. These assays are used for quality assurance after terminal patient room cleans and have been shown to be effective.[6–8] However, research about the implementation of cleaning and disinfection programs for MPE utilizing ATP technology is limited. The goal of this study was to use the ATP bioluminescence assay to evaluate the cleanliness of inpatient MPE.

Methods

Study design and setting

This study was a cross-sectional evaluation of ATP bioluminescence on MPE, both before and after an intervention to improve the cleanliness of MPE at a 525-bed public safety net and teaching hospital. The study period was June 2015 through January 2018, with stepwise implementation on different units. The data were divided into 3 periods: baseline (month 0), implementation (months 1–6), and maintenance (months 7–12). The MPE was identified on acute-care floors and emergency department and included vitals machines (ie, blood pressure cuff, pulse oximeter, and thermometer), ultrasound machines, bladder scanners, and interpreter phones. Following the baseline period, education materials were developed for cleaning the MPE.

Data acquisition

Baseline cleanliness was measured by obtaining ATP samples from 5–15 pieces of MPE at random times from each of the 8 acute-care floors and the ED. Weekly ATP sampling was performed using premoistened ATP swabs according to the manufacturer's instructions (3M Clean Trace NG Luminometer, 3M, St Paul, MN). According to the manufacturer's instructions, a surface with >250 relative light units (RLU) was considered "dirty" and ≤250 RLU was considered "clean."[6]

In total, 3 ATP swabs were individually collected on a single vitals machine (blood pressure cuff, thermometer, and pulse oximeter), and 1 ATP swab was collected on high-touch areas of an additional piece of equipment (ie, bladder scanner, ultrasound, or interpreter phone). The ATP results were sent to nurse educators and managers weekly with machine identity, time of measurement, RLU value, and pass–fail status. Nurse leadership provided data to all staff regularly, with ongoing education. After a 6-month period of weekly measurements and feedback (implementation period), the ATP results were collected biweekly for an additional 6 months (maintenance period).

Data analysis

The median and interquartile range (IQR) was determined from the RLU for each piece of MPE for each period. A pairwise

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Table 1. Baseline, Implementation and Maintenance Median Relative Light Units for Mobile Patient Equipment

	Baseline		Implementation		Maintenance		*P* Value			
	Median RLU (IQR)	No.	Median RLU (IQR)	N	Median RLU (IQR)	No.	Overall	Baseline to Implementation	Baseline to Maintenance	Implementation to Maintenance
Overall	860 (268–1,443)	61	218 (93–533)	579	176 (66–638)	219	<.001	<.001	<.001	.02
Bladder scanner	1,069 (752–1,428)	6	239 (130–530)	47	150 (56–265)	17	.020	<.01	<.01	.32
Blood pressure cuff	429 (83–1,269)	11	194 (109–491)	145	156 (74–558)	54	.280	.54	.37	.71
Pulse-ox	1,522 (309–3,015)	12	443 (189–1,097)	152	539 (176–1,526)	61	.300	.14	.27	.86
Thermometer	482 (208–1,080)	18	108 (48–259)	148	69 (25–106)	57	<.001	<.001	<.001	<.01
Translator phone	1,284 (1,054–1,717)	6	179 (101–389)	74	162 (52–310)	22	.040	<.001	<.01	.55
Ultrasound	820 (428–1,174)	8	676 (461–4,367)	13	329 (100–1,010)	8	.290	.90	.48	.35

Note. RLU, relative light units; IQR, interquartile range.

comparison of median using the Dwass, Steel, Critchlow-Fligner method was used to determine statistical differences among the median RLUs for the baseline, the implementation period, and the maintenance period. Linear regression was performed to determine the trend of the implementation- and maintenance-period ATP results. All analyses were conducted using SAS version 9.3 software (SAS Institute, Cary, NC).

This project was carried out as a quality improvement project and did not meet the definition of research and thus was exempt from the approval of our institutional review board.

Results

Overall, 61 swabs were collected at the baseline from 6 types of MPE (Table 1). The number of swabs collected per MPE type ranged from 6 (bladder scanner and translator phone) to 18 (thermometer). Overall, the median RLU was 860 (IQR, 256–1,443; n = 61). The highest median RLU was observed on pulse oximeters (median, 1,522; IQR, 309–3015; n = 12), whereas the lowest median RLU was observed on blood pressure cuffs (median, 429; IQR, 83–1,269; n = 11).

Overall, the median RLU in the implementation period decreased 75% from the baseline (median, 218; IQR, 93–533; n = 579; $P < .001$). The median RLU decreased for each MPE type during implementation period, ranging from an 18% decrease on the ultrasound machine (baseline median, 820; IQR, 428–1,174; n = 8 to implementation median, 676; IQR, 461–4,367; n = 13) to an 86% decrease on the interpreter phone (baseline median, 1,284, 1,054–1,717, n = 6 to implementation median 179; IQR, 101–389; n = 74). Significant decreases in RLU were also observed for bladder scanners (baseline median, 1,069; IQR, 752–1,428; n = 6 to implementation median, 239; IQR, 130–530; n = 47; $P < .01$) and thermometers (baseline median, 482; IQR, 208–1717; n = 18 to implementation median, 108; IQR, 48–259; n = 148; $P < .001$).

During the maintenance period, 219 swabs were collected for the same MPE types. The median RLU decreased an additional 19% from the implementation period (median, 176; IQR, 66–638; n = 219; $P = .02$). Performance was either maintained or improved relative to the implementation period for all MPE types. Thermometer median RLU significantly decreased from the baseline (median, 108; IQR, 48–259; n = 148) to implementation (median, 69; IQR, 25–106; n = 57; $P < .01$). The pulse oximeter had a small, nonsignificant increase from the implementation period (median, 443; IQR, 189–1,097; n = 152) to the maintenance period (median, 539; IQR, 176–1,526; n = 61). Linear regression indicated a significant decreasing trend during the implementation period (−43.4 RLU/month; $P = .005$) followed by a stable trend in the maintenance period (+8.7 RLU/month; $P = .51$) (Fig. 1).

Discussion

With this study, we have demonstrated a successful MPE cleaning program utilizing ATP technology that was sustained in the 6 months following implementation. Following staff education and ATP data feedback, the data suggest that the equipment was cleaned appropriately. Median RLU decreased by 75% from 860 to 176 during the maintenance period. Thermometers and blood pressure cuffs exhibited significantly lower RLU in the maintenance period.

Although most of the equipment and locations demonstrated improvement in overall RLU values, challenges existed with some equipment and locations. For example, pulse-oximeters and ultrasound machines did not exhibit significant improvement in cleanliness throughout the study. We hypothesize that the small area on the pulse oximeter made it difficult to adequately clean, resulting in a higher RLU. The ultrasound was often tested in the ED which demonstrated higher overall RLUs throughout the study. Frota et al[9] highlighted similar challenges with consistent cleaning in the ED due to the large number of patients in a high-turnover area.

The study did have some limitations. The baseline period was only 1 month in duration, and the sample size was relatively small (n = 61) and may have misrepresented the overall state of the cleanliness of the MPE. The inclusion of select inpatient units was also a limitation. Although ATP technology has advantages, it has some drawbacks as well. Lack of comparability of ATP monitoring to benchmark methods of fluorescent markers and aerobic colony counts has been documented as well as inability

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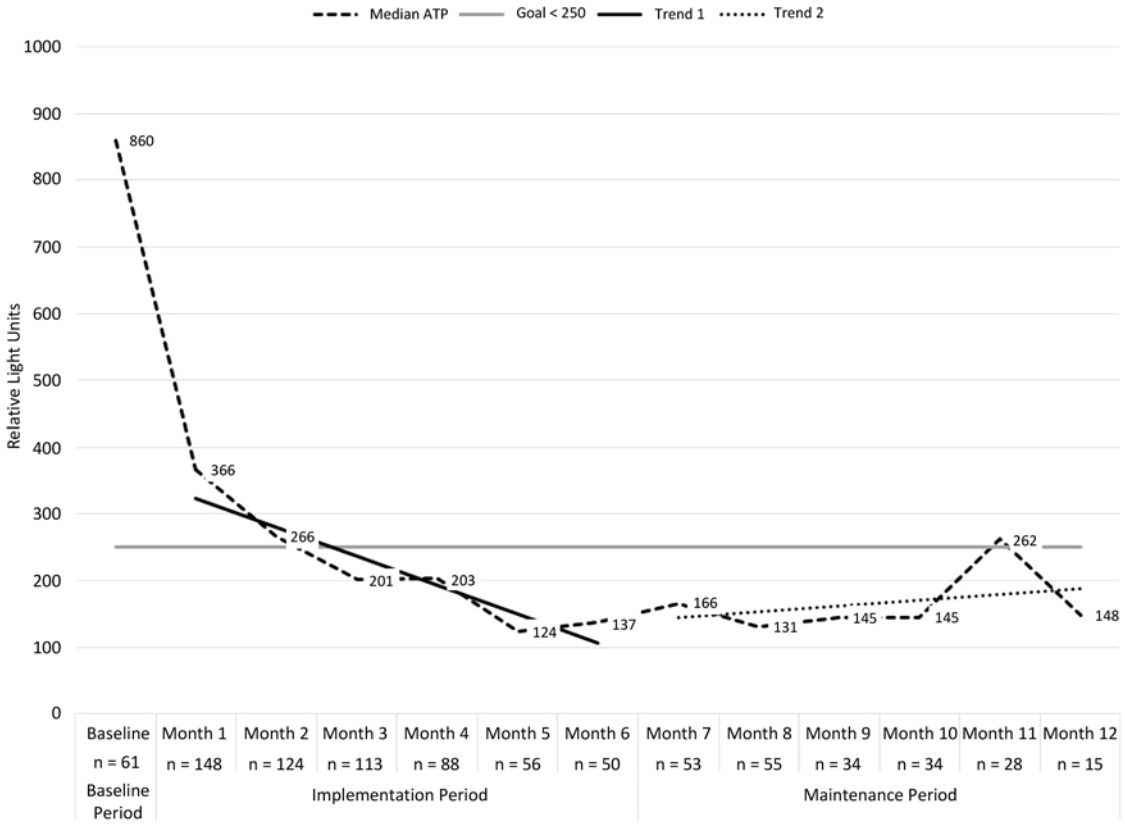


Fig. 1. Monthly median relative light unit measurements for baseline, implementation, and maintenance periods with trend line. ATP, adenosine triphosphate.

to demonstrate actual pathogens on a surface deemed "dirty" by ATP assessment.[5,7]

This study demonstrates a sustainable cleaning program for MPE utilizing ATP technology and feedback. Future directions include evaluating new cleaning techniques for persistently dirty surfaces, broadening the type of equipment that are assessed through ATP, expanding to outpatient settings, and exploring the sustainability in the absence of ATP data feedback.

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