American Journal of Infection Control 000 (2021) 1–4

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief Report

A multiphase intervention of novel color additive for bleach disinfectant wipes improves thoroughness of cleaning in an academic medical center

Kevin Tyan BA [a,b,*], Jerry M. Zuckerman MD [c], Constance Cutler RN, MS, CIC, FSHEA, FAPIC [c], Kunle Modupe MS [c], Dennis Ray MBA [c], Luis Marmolejo MAS [c], Jason Kang BSc [a]

[a] *Kinnos Inc., Brooklyn, NY*
[b] *Harvard Medical School, Boston, MA*
[c] *Hackensack University Medical Center, Hackensack, NJ*

Key Words:
Disinfection
Health care-associated infections
Bleach wipes
Color additive
Fluorescent marker
Adenosine triphosphate bioluminescence
Color indicator

Surface disinfection is critical for preventing health care-associated infections; however, sustaining high-quality cleaning technique is challenging without constant feedback and training of staff. A novel color additive to bleach wipes, Highlight, indicates where surfaces have been wiped and fades to colorless to provide real-time visual feedback of cleaning. In a multiphase interventional study, Highlight reduced failure rates of cleaning based on fluorescent marker removal (15.0%-4.5%) and adenosine triphosphate bioluminescence assay (3.6%-2.5%).

BACKGROUND

Effective surface disinfection plays a critical role in preventing health care-associated infections. There is abundant evidence linking contaminated environmental surfaces to the transmission of nosocomial pathogens, which have been demonstrated to transfer from high-touch surfaces to the hands of both patients and health care workers.[1] The emergence of the coronavirus disease 2019 pandemic has further highlighted the urgent need to continue investing in environmental services (EVS) and improved disinfection practices.[2,3]

Successful environmental cleaning requires 3 core strategies: selecting an appropriate disinfectant product, practicing thorough cleaning technique, and empowering people with training and guidance.[1] In particular, the practice of effective surface cleaning involves proper training, adherence to protocols, and close monitoring with regular feedback. When implemented properly, these combined strategies can lead to significantly improved patient outcomes and cost savings. For example, the introduction of germicidal bleach wipes to an academic medical center in conjunction with staff training and adenosine triphosphate (ATP) bioluminescence monitoring led to a reduction of hospital-acquired *Clostridioides difficile* infection by 85% and cost savings of up to $216,000.[4]

However, sustaining high-quality disinfecting technique over time remains a challenge in many health care settings given the operator variability inherent in the practice of cleaning. Substantial human error can occur during the process of using disinfectant wipes, including failing to achieve thorough disinfectant coverage onto a surface, interacting with a wetted surface before the required wet-contact time has elapsed, or even entirely omitting high-touch surfaces during cleaning.[5] The importance of addressing deficits in disinfection practice is further underscored by evidence linking surface contamination of vancomycin-resistant enterococci with failure by staff to thoroughly clean surfaces rather than a faulty procedure or product.[6] In the short term, human error in cleaning technique may be addressed through educational interventions and monitoring programs that include ATP bioluminescence assays or fluorescent markers (FM). However, improvements are difficult to sustain in the long term without a mechanism for continuous feedback and frequent re-training, particularly given high levels of turnover among EVS staff.[3] For example, one institution that implemented FM monitoring improved their cleaning efficacy from 52% to 83% after 6 months, but found that performance rapidly declined back to baseline (57%) after feedback to EVS was switched from a monthly to quarterly basis.[7] Ultimately, current methods to mitigate human

* Address correspondence to Kevin Tyan, BA, 760 Parkside Ave, Suite 219, Brooklyn, NY 11226.
E-mail address: kevin@kinnos.com (K. Tyan).

Funding/support: Kinnos Inc. provided the product for testing but did not participate in the design or execution of the hospital study. KT is supported by the Harvard Innovation Labs Spark grant.

Conflicts of interest: KT and JK are founders and shareholders of Kinnos Inc. and have patents issued and pending on the Highlight® technology.

https://doi.org/10.1016/j.ajic.2021.11.002

error in cleaning are difficult to sustain due to their retrospective nature, poor scalability, and lack of frequent feedback.[8]

A potential approach to reinforce cleaning practices and maintain improvements over time is through a color additive to disinfectants that provides immediate visual feedback to staff. Highlight (Kinnos, Brooklyn, NY) is a liquid blue indicator that, when dispensed onto bleach disinfectant wipes, provides a temporarily visible bright blue trace to depict wiping surface coverage before fading away to clear in minutes. The blue indicator is designed to dispense through a lid device that attaches onto standard containers of commercially available bleach wipes as previously described.[5,9] Whereas traditional methods of surface cleaning rely on transparent disinfectants that render it difficult for staff to verify thoroughness of cleaning, the visibility of Highlight enables users to self-monitor cleaning technique with each application.[10] The initial color and subsequent fading of the blue indicator serves as a visual reminder of the need to achieve even and thorough coverage of a surface, as well as preventing premature interaction with recently wiped surfaces before the wet-contact time has passed. Thus, this novel approach to improving cleaning performance leverages both immediate visual feedback and reinforcement of training.

METHODS

To determine the effectiveness of Highlight in enhancing thoroughness of cleaning with bleach wipes, a prospective study was conducted at a 781-bed academic medical center (Hackensack University Medical Center, Hackensack, NJ) from July 2021 to August 2021. This study was conducted with a convenience sample of patient isolation rooms across 3 phases lasting 2 weeks each: (1) control phase (N = 39 rooms), (2) Highlight intervention phase 1 (N = 66), and (3) Highlight intervention phase 2 (N = 14). During the control phase, routine terminal cleaning of isolation rooms was performed by routinely scheduled EVS staff using standard bleach disinfectant wipes (Sani-Cloth Bleach Germicidal Disposable Wipe, PDI Healthcare, Orangeburg, NY). During Highlight intervention phases, routinely scheduled EVS staff were provided with Highlight to combine with their standard bleach wipes. All involved EVS staff were a convenience sample based on whenever patient isolation rooms required terminal discharge cleaning. Staff were not directly observed during the cleaning process to minimize potential Hawthorne effect.[8] Disinfection quality was quantified by sampling high-touch surfaces using both FM removal (VeriClean Fluorescent Marking Spray; Diversey, Fort Mill, SC) and ATP bioluminescence assay (Clean-Trace Luminometer; 3M, Maplewood, MN). For FM testing, an EVS supervisor applied the VeriClean spray onto high-touch surfaces prior to cleaning and assessed the sample as a "pass" if the marker was completely removed. For ATP testing, a relative light unit result ≤ 150 was recognized as a passing score. To avoid potential bias from "pre-training" EVS staff, no refresher training was provided on cleaning methods prior to any of the phases. Feedback was provided to EVS workers only when failures were observed in both the control phase and Highlight phases.

RESULTS

During the control phase, cleaning with bleach wipes alone yielded a higher FM failure rate of 15% (41/232 samples) compared to 4.5% (25/560 samples) in the aggregated Highlight phases. Similarly, the control phase yielded a higher ATP failure rate of 3.6% (14/390 samples) compared to 2.5% (20/790 samples) of aggregated Highlight phases. Figure 1 shows a comparison of failure rates of both cleaning performance tests across the 3 phases. Notably, cleaning scores improved over time during the Highlight phases, with the second intervention phase recording no failures across both tests (Fig 2).

DISCUSSION

Our results suggest that the implementation of a color additive to disinfectant wipes that provides real-time visual feedback can improve effectiveness of cleaning. These results are similar to a previous hospital study of Highlight in which its implementation in a 500-bed academic center reduced the ATP failure rate from 5.7% to 0%.[5] Here, a multiphased intervention with Highlight quantifiably improved surface disinfection quality across 2 testing methods,

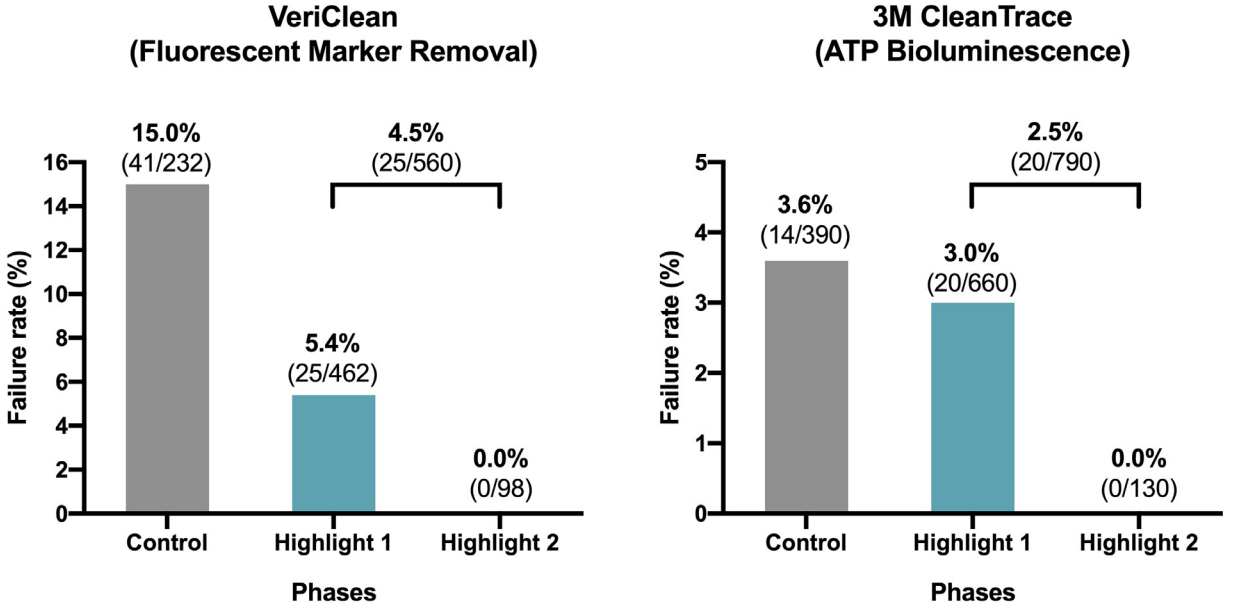

Figure 1. Disinfection quality was assessed by fluorescent marker removal (VeriClean) and ATP bioluminescence (3M Clean-Trace) during the 3 phases of this study (control, Highlight 1, and Highlight 2). The graphs compare failure rates for both assays across the 3 study phases. Numbers above each bar indicate failure rate, numbers in parentheses indicate number of failures recorded out of total number of high-touch surfaces sampled. An aggregate result combining the results of both Highlight phases is included above the bracket.

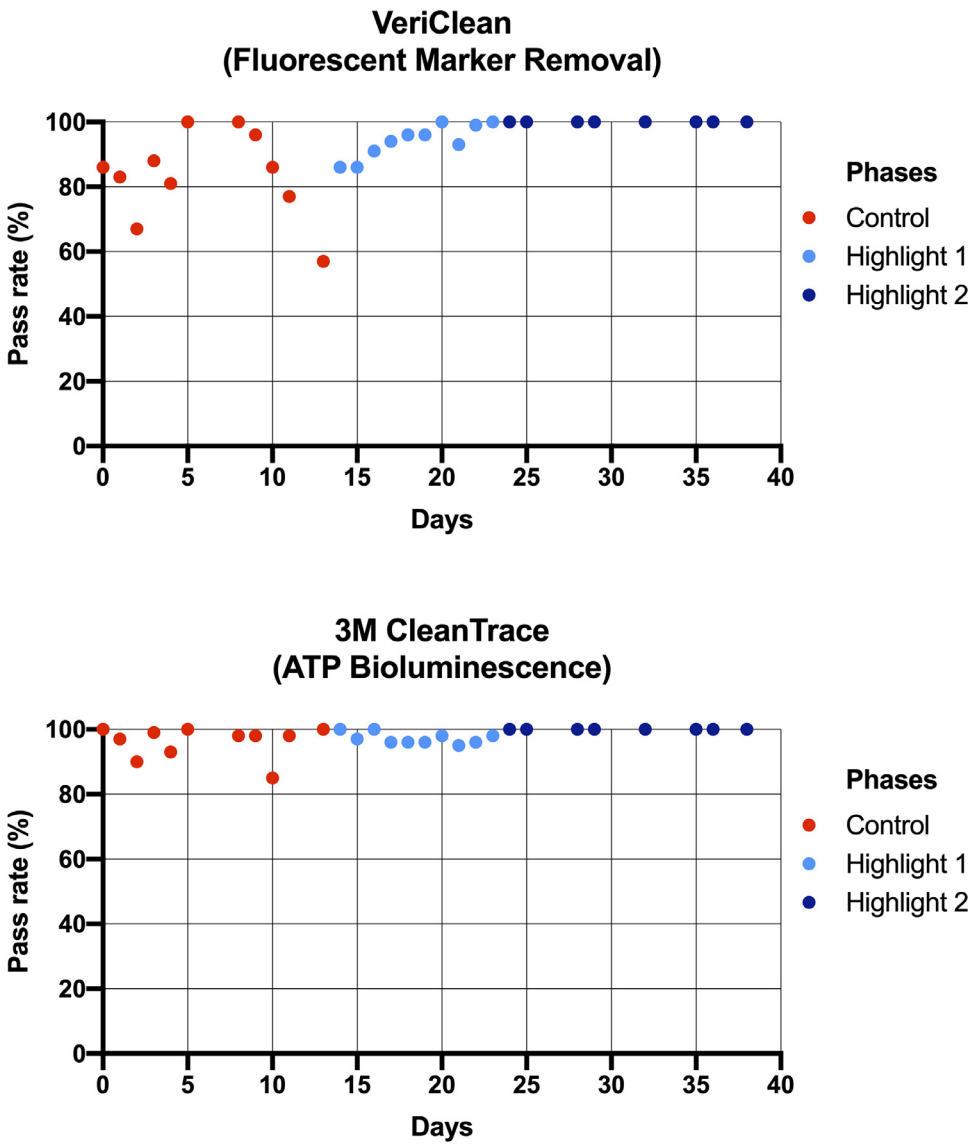

Figure 2. Disinfection quality was assessed by fluorescent marker removal (VeriClean) and ATP bioluminescence (3M Clean-Trace) during the 3 phases of this study (control, Highlight 1, and Highlight 2). These graphs show the passing rates for both assays over the time period of the 3 study phases.

improving FM scores by 70% and ATP scores by 30% over baseline. Importantly, the improved performance and complete elimination of failure between the first and second intervention phases suggests that a solution like Highlight, through constant visual feedback, allows staff to continuously improve and then maintain performance over time.

Our study has some limitations. Only isolation rooms were included in sampling and analysis, and further studies should seek to understand how cleaning practices change across different health care settings. The sample size for the second Highlight intervention phase, despite being of the same 2-week duration, was smaller than the first intervention phase. Nonetheless, the perfect pass rate during this second intervention phase suggests that cleaning technique may steadily improve over time given the continuous intervention and education provided. In addition, because data collection occurred based on a convenience sample of whenever an isolation room required terminal cleaning, we were unable to truly randomize EVS staff between phases, and we did not assess whether the number of different EVS staff or overlap between phases may have affected cleaning scores. Furthermore, while both FM removal[11] and ATP assays[12] have previously been validated as proxies for surface bioburden, other important metrics should be considered in future studies, including microbial culture plates and patient health care-associated infection rates. Importantly, given that the Highlight indicator itself is not known to chemically interact with FM, we conclude that improvements in FM scores are due to enhanced visibility of surface wiping that enable more thorough mechanical wiping technique and full surface coverage. Future studies of this colorized cleaning approach should also focus on changes in patient satisfaction, staff feedback, and other quality metrics.

CONCLUSION

This multiphase intervention of a novel color additive to disinfectant wipes demonstrated improved effectiveness of cleaning when implemented for patient isolation rooms at an academic medical center. The Highlight additive successfully eliminated failure rates of cleaning as measured by fluorescence marker removal and ATP assays, and underscores the importance of continuous feedback and training in the practice of environmental hygiene.

References

1. Rutala WA, Weber DJ. Best practices for disinfection of noncritical environmental surfaces and equipment in health care facilities: a bundle approach. *Am J Infect Control*. 2019;47:A96–A105.
2. Weiner-Lastinger LM, Pattabiraman V, Konnor RY, et al. The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: a summary of data reported to the National Healthcare Safety Network. *Infect Control Hosp Epidemiol*. 2021:1–14. https://doi.org/10.1017/ice.2021.362.
3. Tyan K, Cohen PA. Investing in our first line of defense: environmental services workers. *Ann Intern Med*. 2020;173:306–307.
4. Orenstein R, Aronhalt KC, McManus JE, Fedraw LA. A targeted strategy to wipe out *Clostridium difficile*. *Infect Control Hosp Epidemiol*. 2011;32:1137–1139.
5. Tyan K, Jin K, Kang J. A novel color additive for bleach wipes indicates surface coverage and contact time to improve thoroughness of cleaning. *Infect Control Hosp Epidemiol*. 2019;40:256–258.
6. Hota B, Blom DW, Lyle EA, Weinstein RA, Hayden MK. Interventional evaluation of environmental contamination by vancomycin-resistant enterococci: failure of personnel, product, or procedure? *J Hosp Infect*. 2009;71:123–131.
7. Fitzgerald T, Sholtz LA, Marion N, Turner P, Carling PC, Rupp ME. Maintenance of environmental services cleaning and disinfection in the ICU after a performance improvement project. *Am J Infect Control*. 2012;40:e159.
8. Frota OP, Ferreira AM, Koch R, et al. Surface cleaning effectiveness in a walk-in emergency care unit: influence of a multifaceted intervention. *Am J Infect Control*. 2016;44:1572–1577.
9. Tyan K, Jin K, Kang J. Novel colour additive for bleach disinfectant wipes reduces corrosive damage on stainless steel. *J Hosp Infect*. 2019;103:227–230.
10. Mustapha A, Cadnum JL, Alhmidi H, Donskey CJ. Evaluation of novel chemical additive that colorizes chlorine-based disinfectants to improve visualization of surface coverage. *Am J Infect Control*. 2018;46:119–121.
11. Hung IC, Chang HY, Cheng A, et al. Application of a fluorescent marker with quantitative bioburden methods to assess cleanliness. *Infect Control Hosp Epidemiol*. 2018;39:1296–1300.
12. Sanna T, Dallolio L, Raggi A, et al. ATP bioluminescence assay for evaluating cleaning practices in operating theatres: applicability and limitations. *BMC Infect Dis*. 2018;18:583.