The Use of ATP Bioluminometers and Their Reliability in Assessing Surface Disinfection in Healthcare Applications

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Abstract

Adenosine triphosphate (ATP) bilouminometers are an alternative cleaning inspection tool rather to the widely used visual method. The use of ATP meters has recently been increased into some healthcare facilities where disinfectants are used. ATP readings can be potentially influenced by factors such as soil and cleaner chemistries, and therefore the results may be misleading. The objective of this study was to assess how chemical interference from disinfecting and sanitizing agents can affect the test result in terms of ATP detection. As a mark for reliability, the units were also tested for their detection sensitivity, linearity, and bacterial CFU correlation in their readings. All four ATP meters tested herein showed acceptable linearity and repeatability in their readings, however their sensitivity in detecting microorganisms on the surface was significantly different. In addition, different disinfectant active ingredients were found to cause different effects on the ATP readings for each meter which cannot be generalized due to the difference in the mechanism of ATP reading for each meter. Our findings suggest that ATP bioluminometers are not dependable tools for assuring disinfection in healthcare environments.

Materials and Methods

ATP bioluminometer brands: Kikkoman\Luminutra, Hygiena, 3M and Charm Sciences.

Test solutions: Adenosine 5'-triphosphate, disodium salt (EnzoLife Sciences), Cavicide [IPA, 2-butoxyethanol, QUAT] (Metrex), PSC 1000 [0.1% sodium hypochlorite] (Process Cleaning Solutions), SaniCloth Plus [QUAT, IPA] (Nice Pak), Accel TB, Accel Prevention RTU [0.5% H2O2] (Virox Technologies Inc.), Clorox H2O2 wipes [1.4% H2O2] and Clorox Clean-up disinfectant [1.84% sodium hypochlorite] and Clorox Ultra Bleach [5.5% sodium hypochlorite] (Clorox), Isopropyl alcohol, 70%, lab grade; 0.5% H2O2 food grade, PTS 50 [50% QUAT] (Stepan), Sporicidin [1.58% Phenol, 0.06% sodium phenate] (Sporicidin company).

Bacterial test culture: *Staphylococcus aureus*, ATCC 6538

Swab sample quantity: At any test, 10µL of each of the products/culture solution was placed on the swabs for ATP reading.

Results

Linearity test examines the correlation between serial increase of ATP concentration and the bioluminometer measurement values.

Association test indicates what each units' direct interpretation of *S.aureus* CFUs is to true ATP concentrations.

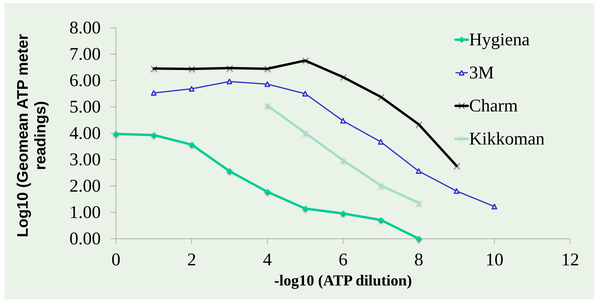

Figure 1. Linearity in ATP readings for 4 different ATP meters.

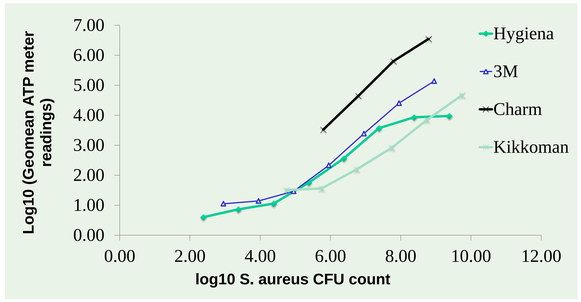

Figure 2. Geometric mean of ATP readings for various dilutions of *Staphylococcus aureus* CFUs

Interference of residual chemistries: Various disinfectant chemicals were tested for their interference with ATP readings. 10 microliters of each disinfectant was placed on the swab along with 10 microliters of the control ATP standard solution for measurement. The results were then compared to the control sample (marked on the y-axis).

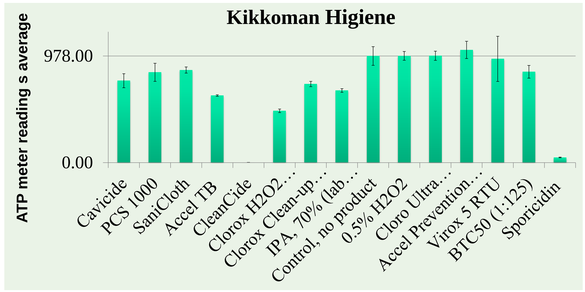

Figure 3. Effects of various disinfectant chemistries on Kikkoman bioluminometer readings, the control was 10^{-6} dilution of the ATP standard solution

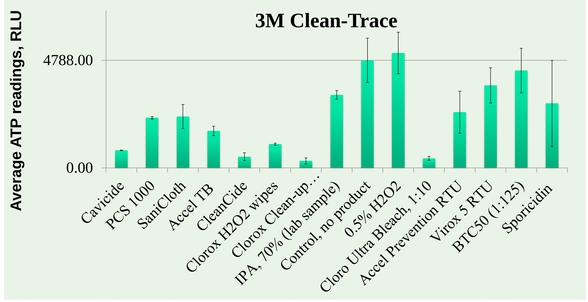

Figure 4. Effects of various disinfectant chemistries on 3M bioluminometer readings, the control was 10^{-7} dilution of the ATP standard solution

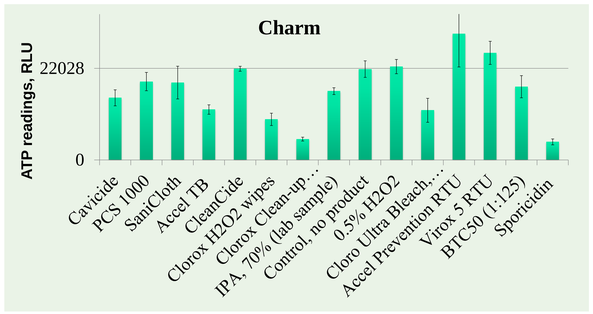

Figure 5. Effects of various disinfectant chemistries on Charm bioluminometer readings, the control was 10^{-6} dilution of the ATP standard solution

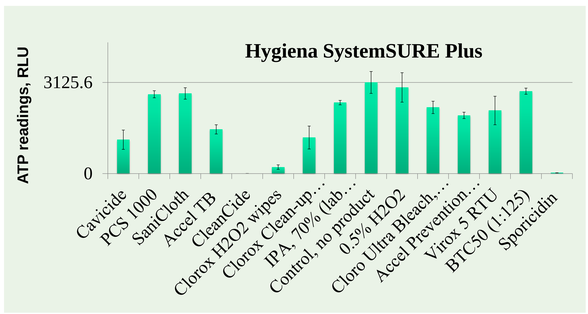

Figure 6. Effects of various disinfectant chemistries on Sciegiene bioluminometer readings, the control was 10^{-8} dilution of the ATP standard solution

Discussions and Concluding Remarks

- A strong positive correlation was observed for the ATP readings versus the ATP counts for both standard ATP solution and the ATP derived from *S.aureus.*
- The detection limit test also showed that there could be a significant difference in the detection limit of each device. Our results show that the detection limit for *S. aureus* ranges from 240 to 6.2 x 10^4 CFUs, considering that the swabs are directed to be used on a 10cm x 10cm area. Therefore in real-life testing, reading zero ATP by swabbing a surface in healthcare environment would certainly be misleading, given if the 100cm^2 area has 6.2 x 10^4 CFUs of a harmful pathogen. This may not be as critical on non-healthcare surfaces as the surface readings may be a result of having residual food particles (milk, etc.), and in the case of microorganisms, the likelihood of having pathogenic microbes is less on non-healthcare surfaces.
- The detection limit of each bioluminometer for the ATP derived from *S. aureus* and the standard ATP are completely different
- It is clearly demonstrated that each chemistry has its own effect in interfering with the ATP readings. Some chemistries (Sporicidin and Cleancide) show the highest quenching among all tested chemicals. The 3M meter also shows that it is the most susceptible to disinfectant chemistries' interference.

In summary, these results suggest that ATP meters cannot be relied upon to evaluate the disinfection of a healthcare surface, since they have limitations in detecting the true count of organisms on the surface, which can cause false confidence. Furthermore the cleaning/disinfecting chemistry residues can have a very adverse impact on ATP readings, which can once again lead to increased false confidence.