COMPARISON OF AMBULANCE CLEANING METHODS

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Enhanced disinfection practices substantially and uniformly reduce biologic load on surfaces

This study was designed to compare the effectiveness of manual cleaning of the patient compartment of ambulances versus using an automatic decontamination system developed by AeroClave, LLC. Using a commercial luminometer to measure for adenosine triphosphate (ATP) levels, the results showed an average 90% reduction in ATP levels between pre-cleaning and AeroClave treatment. Current spray-and-wipe manual cleaning methods appear only partially effective in reducing that biologic load. Using the AeroClave ambulance decontamination system as an adjunct to manual cleaning resulted in a significant and uniform biologic load reduction.

Comparison of Ambulance Cleaning Methods

Abstract

Numerous studies have shown that methicillin-resistant staphylococcus aureus (MRSA) can be found in approximately 50% of ambulances[1,2,3,4]. This may help to explain the results of studies showing that 22% of paramedics have had positive nasal swab cultures for MRSA versus 1.5% of the general public[5,6]. Current spray and wipe cleaning methods have been shown to be only partially effective and sometimes even make the contamination worse by spreading the organism to other parts of the vehicle[7,8]. This study was designed to compare the effectiveness of manual cleaning of the patient compartment of ambulances versus using an automatic decontamination system developed by AeroClave, LLC, a company based in Winter Park, FL.

Six different locations in the patient compartment of 15 Type I ambulances were sampled for adenosine triphosphate (ATP) levels using a commercial luminometer manufactured by the 3M Corporation. Each area was sampled before manual cleaning, after manual cleaning and after the automated AeroClave process. Each vehicle was tested on four separate occasions (on average one week apart) which resulted in a total of 1080 data samples. The results showed an average 50% reduction in ATP levels between pre-cleaning and manual cleaning and an average 90% reduction in ATP levels between pre-cleaning and AeroClave treatment. AeroClave automatic disinfection system provided a substantial improvement over manual cleaning methods when disinfecting the patient compartment of ambulances.

Background

Paramedics, emergency medical technicians (EMTS) and other pre-hospital health care providers are often called to provide immediate health care support to a wide variety of patients, most often not having access to their previous medical history. Having to perform life-saving and invasive procedures on the patient in the confined space of an ambulance can put these workers at an increased risk for exposure to infectious diseases. Proper techniques and proper use of personal protective equipment (PPE) such as gloves, face masks, etc. should help protect the worker. However, recent studies have shown, for example, that paramedics and other first responders have a disproportionately greater rate of nasal colonization of MRSA (22%) versus the general population (1.5%). Other studies have shown that over 50% of ambulances tested positive for MRSA and that MRSA was prevalent in numerous locations within the firehouse. This suggests that there might be transmission of MRSA and other hazardous biologic agents from the patient to the ambulance and into the fire station beyond. Several other studies show that current spray and wipe cleaning methods now used by most EMS providers are ineffective and might actually increase the spread of the organisms onto other surfaces. With the emergence of new deadly and contagious pathogens such as SARS, MERS, Ebola and other multi-drug resistant organisms, perhaps enhanced ambulance and emergency equipment cleaning methods might help to reduce disease exposure risks for the approximately 850,000 EMS personnel in the US[9].

A number of enhanced cleaning methods have been tested over the past several years. UV light, although highly effective against most organisms, is limited by the fact that light does not bend around corners and most modern ambulances have lots of nooks and crannies that the light cannot reach. Hydrogen peroxide vapor requires strict atmospheric control to prevent condensation that can lead to damage of certain materials and electronics. Also, the high concentrations (35-59%) used in the vaporous process are very caustic and have specialized handling, storage, monitoring and PPE requirements. Electrostatic sprayers require the user to enter the potentially contaminated space and, like other manual cleaning processes, efficacy depends on the skill and diligence of the operator.

Since there is very little scientific research supporting claims of any product's long lasting antibacterial properties, it must be assumed that any ambulance is only clean until the next patient gets on board. It has been shown that a number of pathogens can survive on ambulance surfaces for extended periods. Therefore, it is possible that pathogens from a previous patient could possibly infect future patients (or paramedics) if the vehicle is not decontaminated properly. In order to prevent disease transmission amongst pre-hospital care workers and their patients, ambulances must be thoroughly disinfected after every patient transport. The question becomes then, how can you achieve this level of disinfection consistently and cost-effectively while not negatively impacting vehicle operations?

Many factors must be considered when contemplating adding additional equipment and procedures to any department. Beyond the initial equipment cost, what is the recurring operational costs including labor, to operate the system? Can efficacy be demonstrated scientifically? Lastly, and perhaps most importantly, is there a measureable improvement in the health and welfare of the employee, the patient and their families? Because most organizations have limited capital, a careful cost-benefit analysis must be performed considering these and other factors.

Purpose

The purpose of this study was to test the relative efficacy of an automated ambulance decontamination system developed by AeroClave, LLC against current manual cleaning methods as outlined in the test agency's current standard operating procedures. Efficacy would be determined by obtaining ATP measurements from the six sampling sites within each test vehicle before cleaning, after cleaning and after application of the AeroClave process. ATP measurements are widely used in the food service industry as a quick and reliable means of determining the relative cleanliness of surfaces. ATP is found in all living organisms, and although this process does not identify which organisms are present, it gives a quick and cost-effective relative measurement of organic activity on the surface. Typically, a reading of 150 reactive light units (RLU) on the luminometer means the surface is safe enough to prepare food on. A reading from 150-300 RLU means some additional cleaning may be required and a reading over 300 RLU is considered dangerously contaminated and unsuitable for use for food preparation. Our goal was to see whether manual cleaning alone could produce suitably clean surfaces and to compare the effects of the AeroClave system against manual cleaning.

Methods

In order to produce an adequate sampling size we used 15 different ambulances that, though not identical, had roughly the same cabin layout and had patient compartments of roughly the same cubic volume (450-475 cubic feet). These units were a combination of front-line rescues and inter-facility ALS transport ambulances. All were equipped with the AeroClave ADP-PT system which consists of a spray head mounted inside the patient compartment which is connected via flexible plastic tubing to a quick-connect assembly mounted in a rear exterior compartment of the vehicle. The ADP-PT system connects to the AeroClave RDS 3110 unit which injects a precise amount (average 160 ml) of an EPA-registered hospital grade disinfectant (Vital Oxide) into the rear patient compartment nozzle. The AeroClave process takes approximately 30 minutes from start until the unit is ready to be put back in service.

We selected six different high-touch areas as sampling points within the patient compartment: the inside rear door handle, stretcher rail, oxygen regulator knob, squad bench, monitor/defibrillator control surfaces and the horizontal work surface next to the patient stretcher. Each site was sampled before cleaning, after manual cleaning and then once again after the AeroClave process was completed. Per the luminometer manufacturer's recommendation, ATP samples were collected between 60 and 120 minutes after the cleaning cycle was completed to allow for maximum ATP degradation. Each ambulance was sampled on four different occasions at approximately one week intervals. The ambulance crews performed the manual cleaning on their respective units and operated the AeroClave unit attached to their vehicle. In order to insure uniformity in sample collection, a single AeroClave employee was assigned to collect all the ATP samples.

Manual cleaning was performed by the individual unit crew according to their agency's current SOP. First, any large amounts of contaminants such as emesis or blood are removed using paper towels. Then all areas are cleaned using a mild detergent and water-soaked cleaning rag. Next, all high-touch areas (similar to our sampling points) and other possibly contaminated areas are cleaned using an EPA-approved hospital grade disinfectant applied via a hand spray bottle. SOP calls for applying enough disinfectant to moisten the surface and remain visibly moist for the prescribed contact time (usually 10 minutes). All cleaning rags, gloves and other items used are then placed into a biohazard bag and disposed of per department regulations. We witnessed a wide variation in the amount of time different crews took to perform the manual cleaning. Some were as short as two minutes, the longest was 35 minutes. In several instances there was still organic matter residue visible after the crew "completed" their manual cleaning.

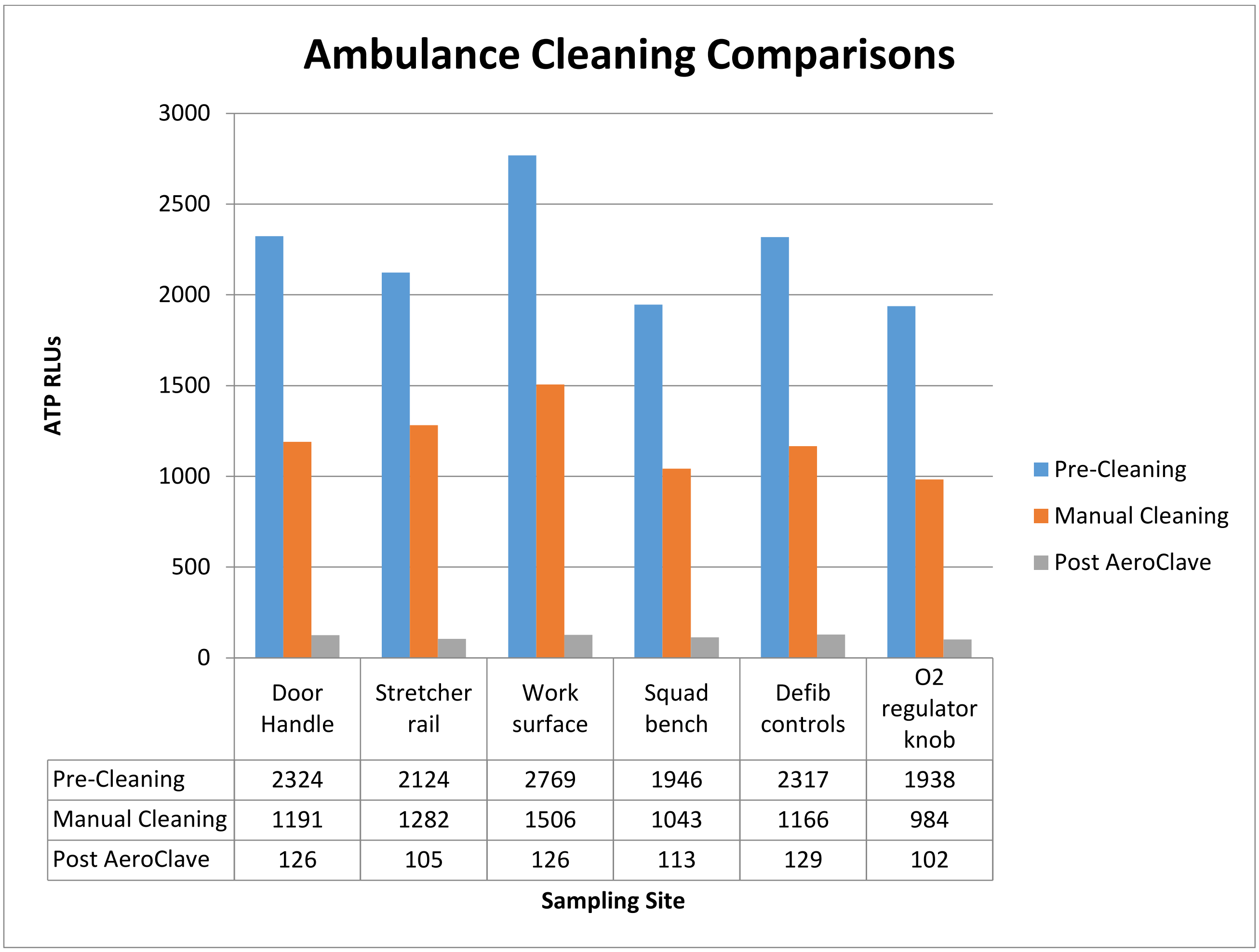
ATP sampling was done using the 3M Clean-Trace NG3 luminometer serial #TNJ 051. It had last been calibrated on May 15, 2015 and all samples were run during the active calibration period. The sampling swabs used were type UXL 100 all from the same batch 1176C having an expiration date of September 13, 2015. Sample sites were swabbed after the prescribed post-clean waiting period (minimum 60 minutes) and a double Z-pattern technique was used where possible. For smaller sites such as the O2 regulator knob, the entire knob surface was swabbed first in a clockwise manner then in a counter clockwise manner. As soon as the sample was obtained it was placed into the luminometer and the reading obtained and recorded on a worksheet. There was a single worksheet for each run of each vehicle (60 total) that contained the ATP readings for the six sampling sites for pre-cleaning, post manual cleaning and after AeroClave treatment. Additional information on the worksheet included unit number, vehicle test run (1-4), date of test, ATP device information, and initials from the person collecting the data. Data was then entered into a Microsoft Excel worksheet for further analysis.

Results

A total of 1080 ATP samples from 15 different vehicles were collected between April 2015 and May 2015. With the exception of a few outlier samples, most of the data points were within +/- 5 % of similar locations throughout the vehicles tested.

Minimum and Maximum ATP values per test phase:

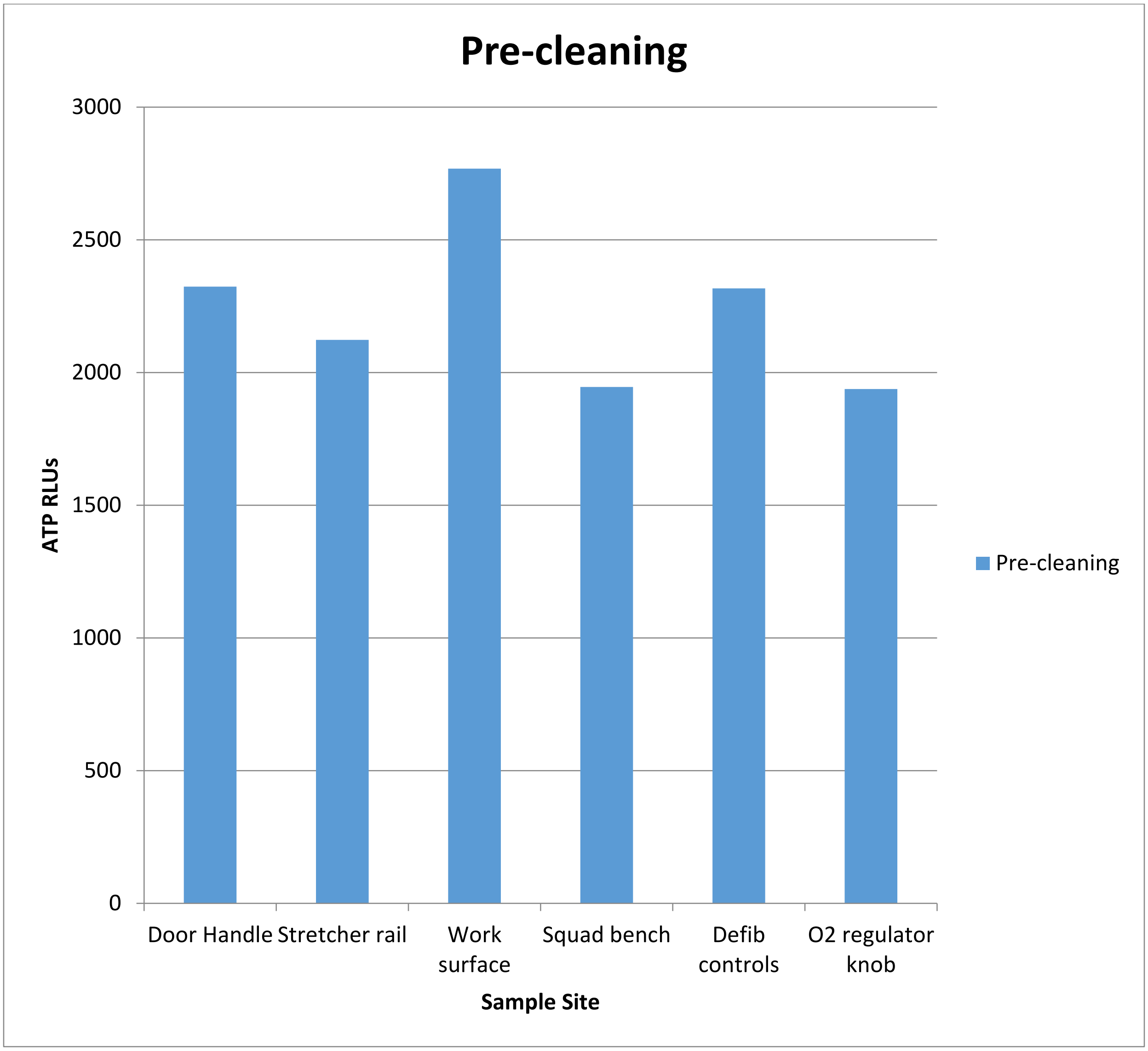
Pre-cleaning		Post manual cleaning		Post AeroClave	
Low	High	Low	High	Low	High
987	5834	659	3244	11	196



	Door Handle	Stretcher rail	Work surface	Squad bench	Defib controls	O2 regulator knob
Pre-Cleaning	2324	2124	2769	1946	2317	1938
Manual Cleaning	1191	1282	1506	1043	1166	984
Post AeroClave	126	105	126	113	129	102

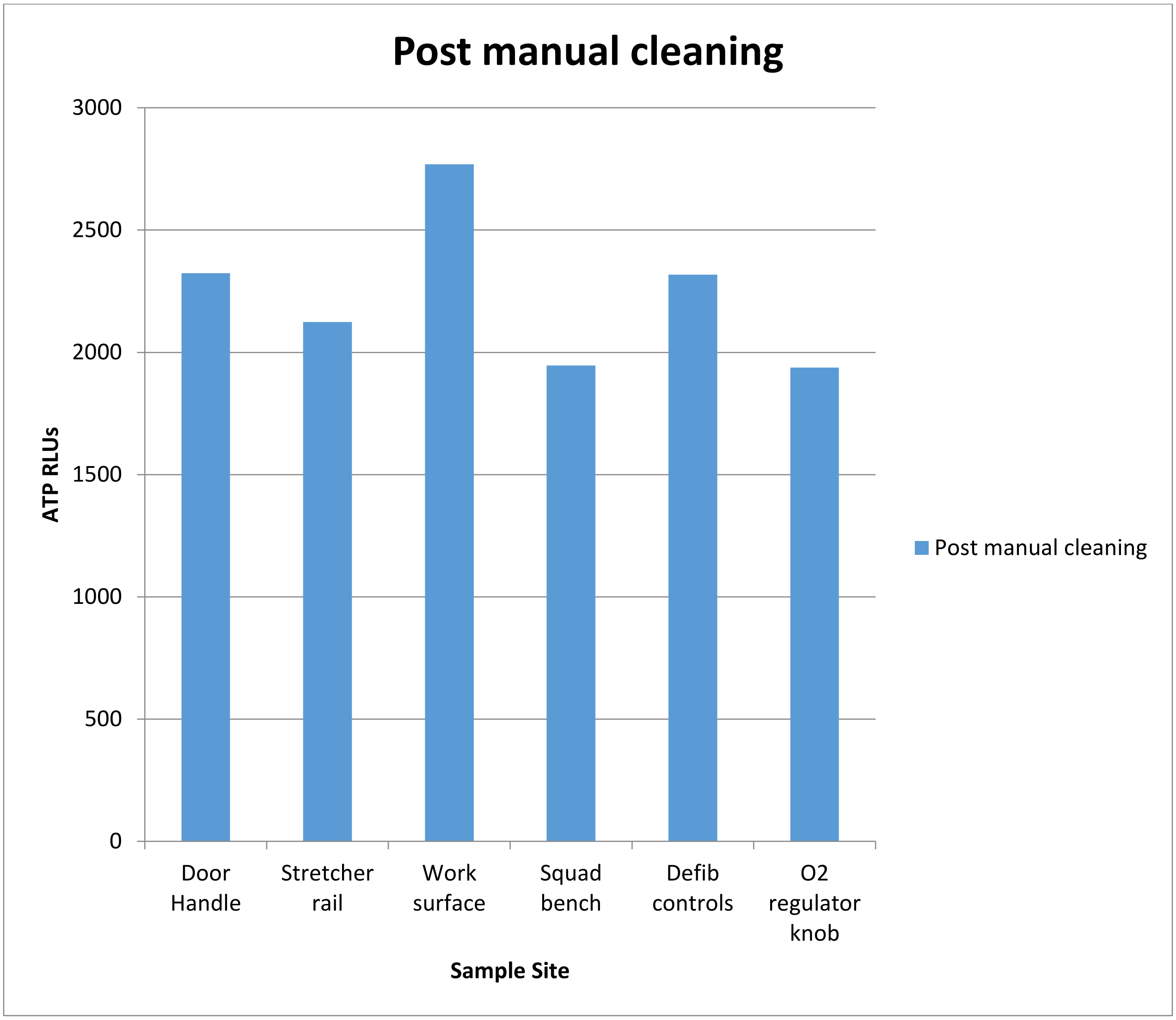
Average ATP pre-cleaning measurements (RLUs) were:

Horizontal work surface	Inside rear door handle	Mon/Defib controls	Stretcher rail	Squad bench	Oxygen regulator knob
2769	2324	2317	2123	1946	1938



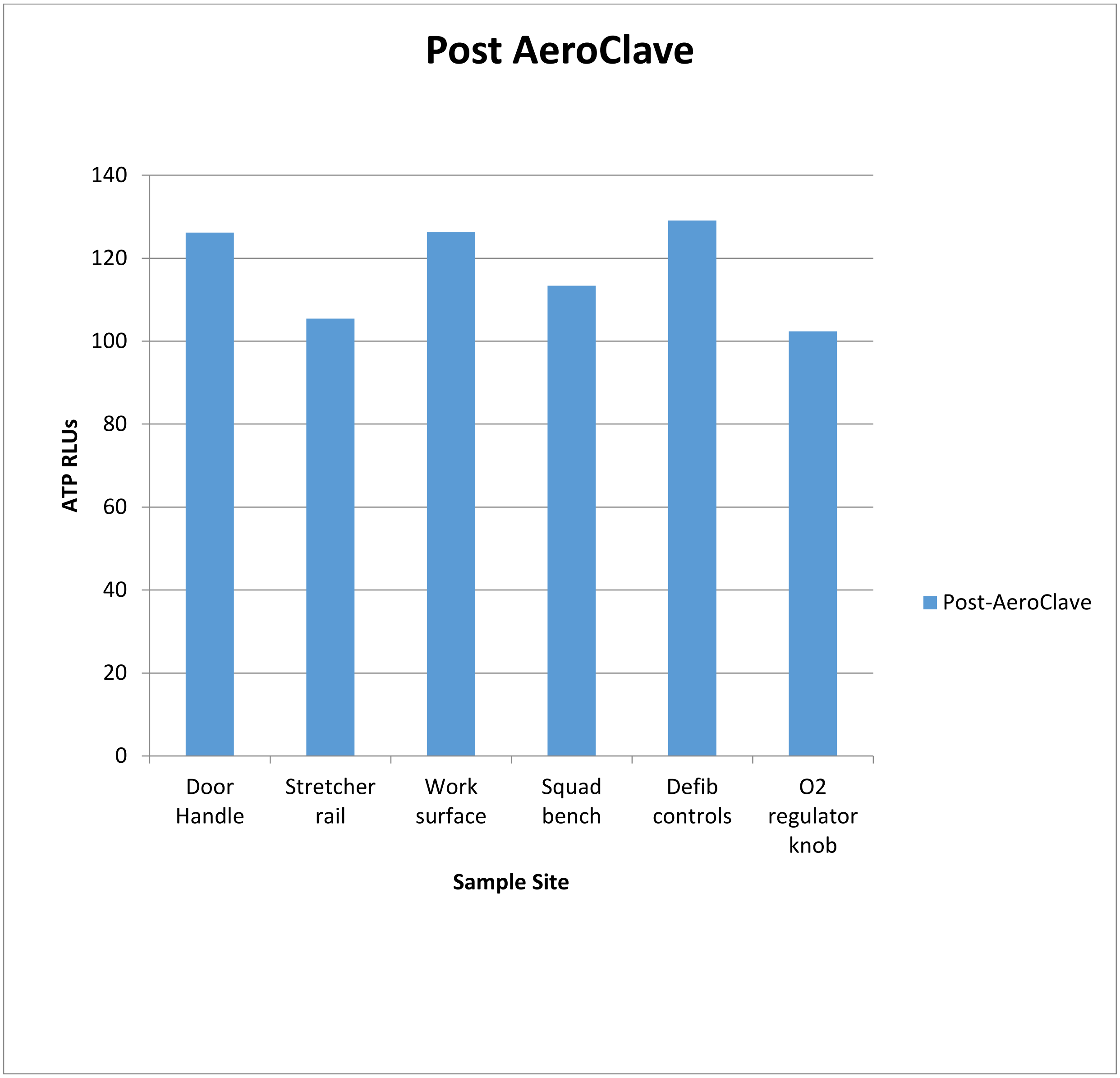
There was an average 47.9% reduction in measurable ATP levels after manual cleaning:

Horizontal work surface	Inside rear door handle	Mon/Defib controls	Stretcher rail	Squad bench	Oxygen regulator knob
1507	1191	1166	1112	1043	984



Compared to pre-cleaning levels, there was an average 94.7% reduction in measureable ATP levels after the AeroClave process:

Horizontal work surface	Inside rear door handle	Mon/Defib controls	Stretcher rail	Squad bench	Oxygen regulator knob
130	126	129	106	114	103



Discussion

The results demonstrate that there appears to be a large biologic load on various surfaces in the back of ambulances (average 2236 RLU). If the food service industry's "dangerously contaminated" limit of 300 RLUs is used as a standard, then the patient compartment of ambulances appear to be very dirty places. The manual cleaning results seem to confirm what other scientific studies have demonstrated, that is, that manual cleaning methods are not very effective in reducing biologic contamination. Using the AeroClave process as an adjunct to manual cleaning showed a significant improvement (90%) in the reduction of biologic activity in the rear of the ambulance. With the exception of one sample, all other samples were below the food industry's "safe" limit of 150 RLU. After reviewing the scientific literature concerning ATP measurements and, after discussions with the luminometer manufacturer, we learned that achieving ATP measurements of zero should not be expected for various reasons. For one, ATP can be found in other, non-living organic matter such as human hair. Also, the 60-120 minute waiting period post treatment is an average time for post-mortem ATP degradation and, as with any statistical average, there are outliers.

Conclusions

Ambulances have high biologic loads as measured by the presence of ATP. This biologic load may contain dangerous pathogens that could be transported to the pre-hospital care givers and/or their patients. Current spray-and-wipe manual cleaning methods appear only partially effective in reducing that biologic load. Using the AeroClave ambulance decontamination system as an adjunct to manual cleaning resulted in a significant and uniform biologic load reduction that, using food industry standards, made the surfaces clean enough to prepare food.

AeroClave's automated, hands free ambulance decontamination system achieves a broad-spectrum, high-level decon of the interior of the ambulance without the operator having to go inside the potentially dangerous environment. It uses an EPA-registered hospital grade disinfectant that has the lowest possible EPA toxicity level, making it extremely safe for the crew and patients. The disinfectant comes ready-to-use and requires no mixing. At approximately $1.00 per cycle, AeroClave's low cost of operation makes it practical to decontaminate after each patient transport if desired.

References

1. Nigram Y, Cutter J. A preliminary investigation into bacterial contamination of Welsh emergency ambulances. Emerg Med J 2003; 20: 479-482.
2. Roline CE, Crumpecker C, Dunn TM. Can methicillin-resistant Staphylococcus aureus be found in an ambulance fleet? Prehosp Emerg Care 2007; 11: 241-244.
3. Alves DW, Bissell RA. Bacterial pathogens in ambulances: results of unannounced sample collection. Prehosp Emerg Care 2008; 12: 218-224.
4. Roberts C, No B. Environmental surface sampling in 33 Washington State fire stations for methicillin-resistant and methicillin-susceptible Staphylococcus aureus. American Journal of Infection Control 2014; 42: 591-596.
5. Al Amiry A, Bissell RA. Methicillin-resistant staphylococcus aureus nasal colonization prevalence among Emergency Medical Services personnel. Prehosp Disaster Med 2013; 28: 348-352.

6. Roberts MC. MRSA colonization high in firefighters, paramedics. Am J Infect Control 2011; 39: 382-389.
7. Ramm L, Siani H. Pathogen transfer and high variability in pathogen removal by detergent wipes. Am J of Inf Control 2015
8. Sattar, S, Maillard, J. The crucial role of wiping in disinfection of high-touch environmental surfaces: Review of current status and directions for the future. Am J of Inf Control 2013; 41: S97-S104.
9. http://www.cdc.gov/flu/weekly/pastreports.htm