An Evidence-Based Case for the Germ-Zapping Robot™

How pulsed xenon UV disinfection kills the pathogens in the hospital environment that cause dangerous and costly infections

SUMMARY

Healthcare associated infections (HAIs) remain a serious and potentially lethal problem for patients and a significant source of unreimbursed expense for hospitals. High-touch surfaces in patient environments are well-established sources of infections, but traditional cleaning regimens fail to eliminate many pathogens.

A growing number of healthcare organizations are turning to new technologies to complement standard cleaning protocols. Most of these technologies have been shown to kill microorganisms in the laboratory setting. It is known that these tests do not reflect the real-world environment. When evaluating these technologies, it is essential to review the studies published in the scientific literature that give evidence of the technology's ability to reduce actual rates of HAIs.

Pulsed xenon ultraviolet light disinfection, introduced to the healthcare market in 2010 by Xenex Disinfection Services, is the only environmental disinfection technology with reported HAI rate reductions in multiple peer reviewed research articles. The Xenex system kills a broad range of pathogenic microorganisms, including hardy C. *diff* spores, on high-touch surfaces within 10 to 15 minutes per room. Hospital environmental service staff are easily trained to use the Xenex robot.

This paper discusses the peer reviewed research that has evaluated the effectiveness of the Xenex technology and the financial benefits associated with the adoption of this technology.

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THE PROBLEM

Despite signs of recent progress, healthcare associated infections (HAIs) remain the largest source of preventable harm to patients. A recent survey by the Centers for Disease Control and Prevention (CDC) found that 1 in 25 hospital patients had at least one HAI and 75,000 hospital patients die from them each year.[i] Other estimates are far higher, making HAIs one of the leading causes of death in the U.S.

The CDC reported in March 2014 that some infections reported to its National Healthcare Safety Network had fallen significantly from 2008 to 2012, but there had been minimal decreases for both hospital-onset *Clostridium difficile* infections (CDI) and hospital-onset methicillin-resistant *Staphylococcus aureus* (MRSA) bloodstream infections, both associated with contaminated patient environments.[ii]

C. difficile, a virulent form of diarrhea, is linked to 14,000 American deaths each year. It is the most common HAI, causing 12% of all healthcare associated infections, while MRSA is second at 10.7%. Those and other infections not related to the use of medical devices or surgeries account for 52.6% of all HAIs.[i]

HAIs are an incredible economic burden on the US healthcare system. They cause longer lengths of stay and more intensive care, accounting for $40 billion in excess costs in 2009, according to the CDC. The average total cost for a single inpatient CDI is more than $35,000.[iii] An array of public and private sector payment initiatives makes high rates of HAIs a significant detriment to the bottom line of hospitals and other healthcare facilities. One analysis found that a hospital with $50 million in annual Medicare inpatient revenue might have as much as $6.6 million at risk as a result of high infection rates.[iv]

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Beazley, a leading insurer of hospital professional liability risks that maintains a claims database covering 39% of U.S. hospital beds, estimates that the average cost of all successful medical malpractice claims rose 2% in 2013 to $492,000.[v] One recent case cited by Beazley involved a New York hospital, which paid $17.9 million to a patient who underwent quadruple amputation as a result of a virulent infection acquired in the hospital.

An infection can also become a serious public relations problem, causing harm to the hospital's reputation as a safe place to seek care. Lawsuits are reported in the local news and in online reviews for hospitals. Infection rates are publicly reported on the Centers for Medicare and Medicaid Services' (CMS) Hospital Compare website, and the Leapfrog Group includes infections in its calculation of the Hospital Safety Score, which garners widespread media attention.

Conversely, visible action to improve room cleanliness is a significant contributor to higher patient satisfaction, a key component of performance under the Hospital Inpatient Value-Based Purchasing Program.

THE HOSPITAL ENVIRONMENT AND INFECTIONS

The role of the healthcare environment in the transmission of infections is becoming clearer. Serious pathogens, such as MRSA, *C. difficile* and vancomycin-resistant *Enterococcus* (VRE), have been isolated from the environment. Environmental sources have been linked to multiple outbreaks of infections due to these pathogens.[vi]

Almost everything that comes into contact with a patient eventually becomes contaminated with bacteria, which makes it easy for the bacteria to transfer between surfaces and people.[vii]

Traditional cleaning regimens using bleach or quaternary ammonium compounds reduce room contamination but fail to eliminate many pathogens. These compounds require long dwell times on hard surfaces, time that most staffs don't have. And those compounds are not recommended for soft surfaces, which might get no more than a dusting, even in a terminal cleaning.

There is significant variability in cleaning procedures between hospitals and among staff within the hospital. A comparative study at Central Texas Veterans Health Care System in Temple, Texas, found that consistency in patient room cleaning was lacking.[viii] "High residual colony counts were observed on the toilet seats post-cleaning ... this may be due to human inconsistency or memory failure regarding which parts of the room have been cleaned, a common problem with repetitive tasks," the authors found.

Hospital rooms are full of equipment, which makes it even easier to acquire infections from the environment. Devices, screens, monitors and tubes can all harbor bacteria, but cleaning staff are not always permitted to touch this equipment, and it may not be known exactly whose duty it is to clean it.[vii] Many devices are becoming increasingly complex and difficult to clean, even for experienced clinicians.

Worse, amid tightening budgets, environmental services departments are often targeted for cost savings. According to Patti Costello, executive director of the Association for the Healthcare Environment, "ES teams are under pressure to turn rooms more quickly and care for the environment with fewer resources. There doesn't seem to be widespread acknowledgement of the data that support the environment as key to improved satisfaction scores and outcomes with respect to reducing infection rates."[xi]

TECHNOLOGICAL SOLUTIONS

A growing number of healthcare organizations are turning to technologies that complement standard cleaning programs. While some of these technologies have laboratory data concerning their ability to kill organisms, most of the solutions do not have published data on the impact on both HAI rates and hospital operations.

For example, one study found that the use of hydrogen peroxide vapor (HPV) disinfection was associated with an overall reduction in multi-drug resistant organisms (MDROs) of 64%, although the patients' reduced risk of acquiring CDI, MRSA and gram-negative bacterial infections could not be solely attributed to HPV.[x]

Ultraviolet light has been used for air and water disinfection for decades. There are now dozens of companies marketing mercury bulb UV light devices for surface disinfection in healthcare facilities. Mercury bulbs contain elemental mercury, which is a toxic substance. Special handling is necessary if a mercury bulb breaks, and special disposal requirements may apply depending upon the amount of mercury in the bulb and applicable regulations, such as state or Environmental Protections Agency (EPA) rules.

Pulsed xenon ultraviolet light (PX-UV) room disinfection was introduced to the healthcare market in 2010 by Xenex Disinfection Services. (The highly portable device has been dubbed the "Germ-Zapping Robot.") The Xenex system works by pulsing xenon, an inert gas, at high intensity from an ultraviolet flashlamp. This produces the full spectrum of germ-killing UV-C, which penetrates the cell walls of microorganisms, including bacteria, viruses, mold, fungus and spores. DNA is instantly fused so that microorganisms are unable to reproduce; PX-UV effectively kills these organisms on surfaces without contact or chemicals.

The full germicidal spectrum emitted by PX-UV eliminates a wide range of pathogens within five minutes at an efficiency rate of 99.9%. Treating most rooms involves two to three cycles, for a total of 10 to 15 minutes added to the time for the terminal cleaning process. It reaches soft surfaces such as drapes, as well as equipment that may be off-limits for housekeepers. Existing environmental services staff members are easily trained to use the robot. In many cases additional staff is not required to implement a Xenex program.

Xenex has tested its full spectrum UV on 22 microorganisms, studying nearly 2,000 samples in several independent labs all over the world. It also is able to deactivate non-enveloped viruses two meters away in any direction.

RESEARCH FINDINGS

PX-UV is the only environmental disinfection technology with multiple peer-reviewed research articles demonstrating the impact of the technology on actual infection rates. Some of the most significant research includes:

- A retrospective study of the effect of using Xenex following discharge cleaning of contact precautions rooms and other high-risk areas at Westchester Medical Center, a 643-bed academic medical center in Valhalla, N.Y., showed greatly reduced rates of hospital-onset MDROs and CDI (see table).[xi]

RATES OF HAIs BEFORE AND DURING PX-UV DISINFECTION AT WESTCHESTER MEDICAL CENTER

	BEFORE ULTRAVIOLET DISINFECTION		DURING ULTRAVIOLET DISINFECTION		
Organism	**No. of cases**	**Rate/1,000 patient days**	**No. of cases**	**Rate/1,000 patient days**	**% change**
VRE	443	0.90	257	0.73	18.9%
C. difficile	390	0.79	228	0.65	17.7%
MRSA	224	0.45	116	0.33	26.7%
MDR*	260	0.52	148	0.42	19.2%
All HAIs	1,320	2.67	749	2.14	20.6%

* Multiple-drug-resistant gram-negative bacteria

- In July 2013, researchers at 140-bed Cooley Dickinson Hospital, Northampton, Massachusetts, reported a decrease of 53% in hospital onset CDI rates, as well as reductions in related deaths and colectomies, after hospital-wide implementation of Xenex.[xii]
- PX-UV disinfection was found to be equivalent to bleach in reducing MRSA and bacterial heterotrophic plate counts (HPCs) on five high-touch surfaces in 20 patient rooms at Central Texas Veterans Health Care System, Temple, Texas.[viii] In this study, one set of rooms was cleaned thoroughly with a bleach compound; the other set had only visible soil removed with bleach, followed by PX-UV disinfection. The HPC count was reduced by 76.3% in the manually cleaned rooms, and by 98.1% in rooms disinfected with Xenex; the MRSA count was reduced by 91.1% in the manual arm and by 99.4% in the PX-UV arm.

COMPARING UV TECHNOLOGIES

A 2015 study by a team from several northern Ohio hospitals examined the effectiveness of PX-UV for killing of C. *difficile* spores, MRSA and VRE on glass surfaces and in rooms with high pathogen concentration.[xiii] The study also examined factors such as the effective pathogen-killing distance of PX-UV and whether shading from the direct field of radiation had an effect on efficacy. In addition to controlled laboratory work, there were two phases of the study, one on uncleaned patient rooms; another on terminally cleaned patient rooms. Finally, the authors compared results on PX-UV with their earlier research on continuous UV radiation with mercury bulbs.

The study found that Xenex, used in two room locations for a total of 10 minutes, effectively reduced recovery of C. *difficile* spores, MRSA and VRE in hospital rooms, including on high-touch areas (See table, below).

PHASE 1: CONTAMINATION BEFORE AND AFTER PX-UV (WITHOUT TERMINAL CLEAN) *

	C. *difficile* positive sites	MRSA (mean colony-forming units, or CFU)	VRE (mean CFU)	HPC (mean CFU)
Before	12%	9	21	522
After	3%	2	0	2

* Rooms did not previously house a C. difficile patient but C. difficile spores were recovered

PHASE 2: CONTAMINATION BEFORE AND AFTER PX-UV (WITH TERMINAL CLEAN) *

	C. *difficile* positive sites	MRSA (mean CFU)	VRE (mean CFU)	HPC (mean CFU)
Before	19%	96	12	934
After	8%	12	1	17

* 42% of phase 2 rooms previously housed a C. difficile patient

EFFECT ON PATIENT SATISFACTION

A different kind of study was undertaken at Trinity Medical Center, a 320-bed acute general medical and surgical hospital located in Birmingham, Alabama.[xiv] The study was designed to evaluate whether the introduction of Xenex had a positive impact on patient satisfaction.

Satisfaction was measured using the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey. Cleanliness of the hospital environment is one of the questions included in the HCAHPS survey. In 2011, prior to the introduction of the Xenex system, HCAHPS scores for cleanliness and the overall rating of the hospital placed it below the national average. "After the introduction of the PX-UV system, the score for cleanliness and the overall rating of the hospital rose from below the 50th to the 99th percentile," the study authors wrote. As a result of this improvement, the hospital received the maximum 1% of at-risk reimbursement from Medicare through the value-based purchasing program, totaling more than $1 million.

All the other nine HCAHPS parameters being measured, including communication and staff responsiveness, also improved over the same period. No other initiatives were introduced during this period, and there were no changes in staff or leadership.

RETURN ON INVESTMENT

Implementing PX-UV not only reduces the pathogens that caused infections, it also saves millions of dollars spent treating them – costs that often cannot be recouped through reimbursement.

In August 2011, Cone Health, a multihospital system in Greensboro, North Carolina, announced results of research that found a new approach to infection control reduced the total number of HAIs by 42% from the first half of 2010 to the same period in 2011, leading to sizeable savings for the system.

The program included the use of Xenex's automated room disinfection system; a renewed commitment to consistent hand hygiene for everyone; expanded MRSA surveillance testing; the addition of infection prevention professionals; the use of an electronic data mining system; and expanded education of personnel, patients and visitors.

"Using a combination of practices, tools and technologies, including Xenex's room disinfection system, we were able to reduce our MRSA infections to zero in our ICUs," said Terry Akin, Chief Operating Officer at Cone Health. "This has had the added benefit of saving the organization and community an estimated $2.3 million in infection-associated hospital costs. We consider the program a success."

In June 2013 Cone Health published results showing the same approach had reduced the rate of all hospital-acquired MRSA infections at its three acute care hospitals by 56% during a six-month period from July 2011 to January 2012.[xv]

CONCLUSION

Payment penalties for high rates of healthcare-associated infections, concerns over healthcare quality, new consumer awareness of hospital ratings and other factors are making inaction on HAIs increasingly problematic.

Standard cleaning regimens have been shown to be inadequate in removing the dangerous pathogens that may infect the next patient.

Xenex provides infection preventionists and environmental service teams with a powerful tool to significantly reduce potentially harmful microorganisms in the healthcare environment. Many of our customers have been able to implement Xenex without the need for additional staff and have seen only a slight increase in room cleaning times. Peer reviewed published studies demonstrate that disinfecting with Xenex is an effective means to reduce infection rates.

With the nature of payment penalties and legal settlements, avoiding even a handful of infections easily covers capital costs for Xenex and significant return on investment long into the future.

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