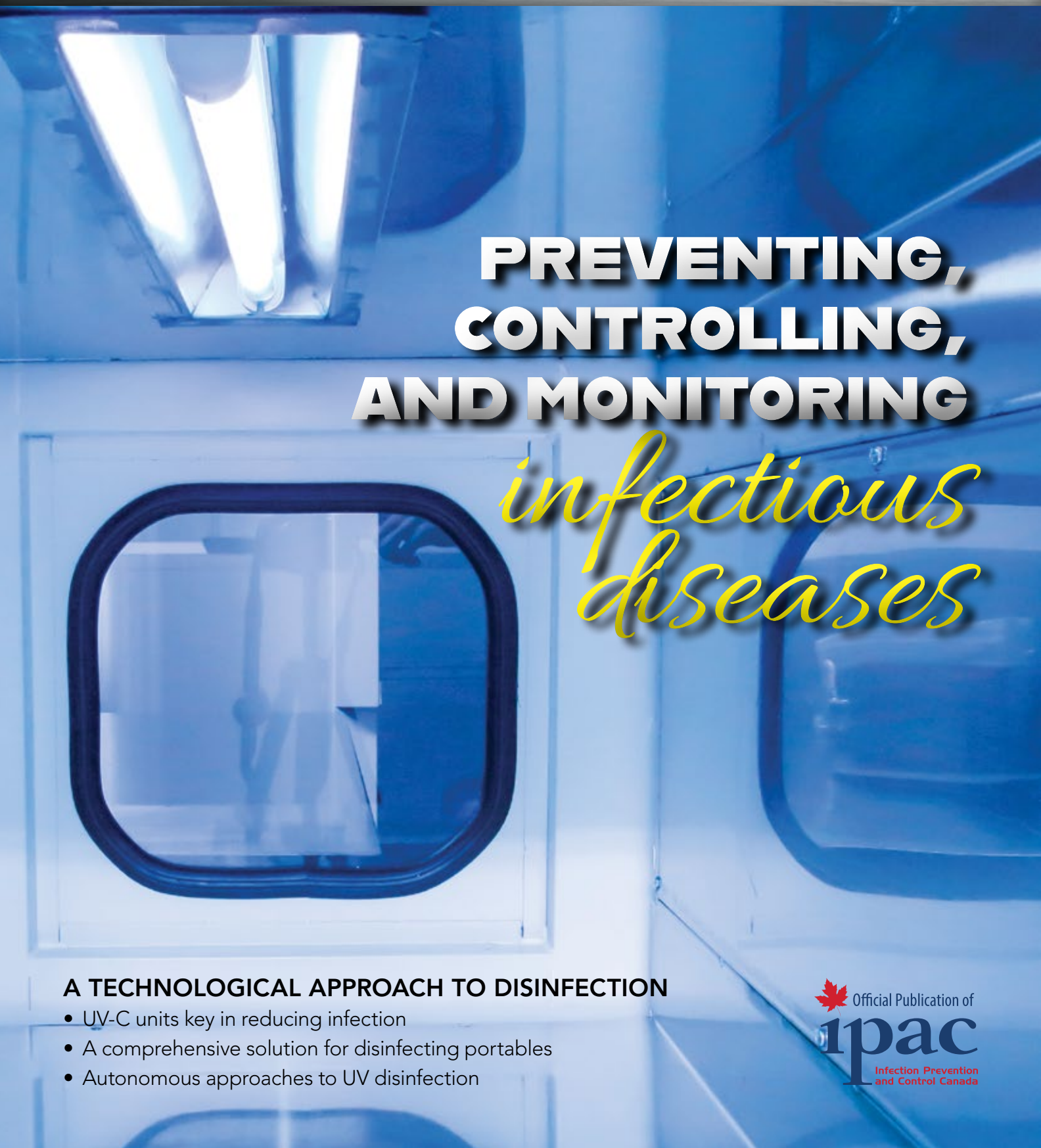
INDUSTRY INNOVATIONS

Where Product Innovation Meets Best Practice

VOLUME 1, NUMBER 2, WINTER 2019



PREVENTING, CONTROLLING, AND MONITORING *infectious diseases*

A TECHNOLOGICAL APPROACH TO DISINFECTION

- UV-C units key in reducing infection
- A comprehensive solution for disinfecting portables
- Autonomous approaches to UV disinfection

Official Publication of ipac Infection Prevention and Control Canada

Chronos

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INDUSTRY INNOVATIONS

IPAC CANADA – THE SMART WAY TO ADVANCE INFECTION PREVENTION AND CONTROL BEST PRACTICE EVERY DAY.

PUBLISHED FOR IPAC-CANADA BY:

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VISION

IPAC Canada – No preventable infections. Ever.

MISSION

IPAC Canada – We inspire, nurture and advance a culture committed to infection prevention and control.

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"In the IPAC world, we accept that many **battles** to implement best practices in **disinfection** will be lost as clinical and environmental service resources are **stretched thin**."

Foreword

Dear IPAC Canada members,

Welcome to the second issue of *Industry Innovations*, IPAC Canada's publication showcasing new and innovative technologies, and how their implementation can assist our activities preventing, controlling, and monitoring infectious diseases in healthcare settings.

On this issue's theme:

In the IPAC world, we accept that many battles to implement best practices in disinfection will be lost as clinical and environmental service resources are stretched thin. Reservoirs in the healthcare environment remain a key source for investigation of nosocomial infections even with standardized disinfection practices and documentation of cleaning activities. Gathering evidence that our healthcare environments are contributing to rates of infection is not difficult in an era where surface swabs for microbiological testing and ATP monitoring is readily available (if investigative IPAC budget allows). Whether or not we establish a probable case-link to an environmentally sourced HAI; post-investigative recommendations typically include supplementing existing manual cleaning processes with more manual cleaning processes. As new considerations to our practices like the looming threat of persistent contamination with C. auris emerge, we may be stuck rehashing additional cleaning recommendations to ad-hoc problems and fighting resource limitations until we have other solutions to work with.

Volume 1, Issue 2: "UV Disinfection," features industry whitepapers examining a disinfection technology that has the potential to grant clinical teams some peace of mind by adding a quality assurance measure following terminal cleaning and shared equipment disinfection processes. I have been following UV disinfection products closely as we see gradual futuristic evolutions to the automated sequencing of UV disinfection workflow and further research into the laboratory-tested inactivation and destruction of microorganisms under high-intensity ultraviolet C (UV-C) lamps. In Canada, there have been dispersed implementations of the technology in from early adopters; some with promising results in reduction of contact transmissible infections, others with unfortunate stories of equipment sitting vacant in storage. Following real-world evidence as UV technology is adopted more broadly in Canada and around the world will be the ultimate test of how and if UV disinfection will become a game changing solution to our environmental disinfection practices.

Additional reading:

In my home province of Ontario, room scale portable UV disinfection received a substantial assessment in a 2018 Health Quality Ontario Health Technology Assessment article titled 'Portable Ultraviolet Light Surface-Disinfecting Devices'. I recommend this review as supplementary reading to this publication to anyone with interest in the intricacies of the technology and the current literature review assessing the quality of UV disinfection research.

Some due gratitude:

This issue marks the end of the first publication year. Thank you to everyone who has opened Industry Innovations and to our industry partners showcased in our inaugural publication volume. We hope that this biannual series is providing an interesting future-focused look at upcoming technologies in the IPAC world and giving frontline practitioners ideas about how their practices may evolve.

Feedback, recommendation for future issues, and submissions are always welcome.

Madison Moon, MPH, CIC
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UV-C and Moonbeam3

The Problem: Healthcare associated infections (HAIs) are a significant source of morbidity and mortality in Canada and around the world. It is estimated that in Canada, one in every nine acute care patients develops an HAI as a result of their exposure to a healthcare facility. This translates into 220,000 cases of HAIs with at least 8,000 deaths in Canada ever year (Zoutman, 2003). Causes of HAIs include the patient's own endogenous flora and exogenous sources of pathogenic microorganisms; such as contaminated environmental surfaces and shared patient care equipment. To reduce the infection risk from contaminated surfaces, including the use of emerging disinfection technologies, such as portable UV-C units may play an important role.

Background: Studies have shown that the acute care environment can act as a reservoir in healthcare settings (Wille, 2018) (Shams 2016). It has been demonstrated that a patient entering a room that was previously occupied by a colonized or infected patient may have up to six times greater risk of acquiring the same infection (Cohen, 2018), due in part to the role of the environment in transmission of pathogenic organisms. A recent review article by Wu (2019) analyzed 12 studies investigating the role of the prior room occupant causing environment dissemination of pathogens and determined a weighted odds ratio of 2.69 that exposure to an infected or colonized prior room occupant or roommate increased the risk of an HAI for certain pathogens.

Environmental Disinfection: One of the main interventions designed to interrupt the chain of infection is routine cleaning and disinfection of environmental surfaces and patient care equipment (collectively "surfaces"). Unfortunately, data has also shown that pathogenic

microorganisms can live on surfaces for days to months, depending on the organism (Kramer, 2006), and previous studies have shown that cleaning and disinfection of patient rooms, operating rooms and shared patient care equipment is suboptimal (Carling, 2008) (Jefferson, 2011) (Havill, 2011).

In one large 23 hospital study (Carling, 2008) less than 50% of patient room surfaces were cleaned on patient discharge. In another study (Jefferson, 2011), less than 25% of operating room surfaces were cleaned between cases in a six-hospital study (Jefferson 2011). A study by Havill (2011) similarly found that portable blood pressure units on rolling casters, could be used on multiple patients per day and were inconsistently cleaned, often showing high aerobic colony counts and ATP RLU readings.

Wong (2016) attempted to measure the effectiveness of cleaning in a different way in a 728-bed hospital in -Vancouver BC. They tested five high-touch surfaces and the floor for MRSA, VRE, and *Clostridioide*s difficile before and after cleaning/disinfection. Prior to discharge cleaning 63.9% of the rooms had at least one surface positive for one of these pathogens (11.8% of all surfaces). After cleaning 52.5% of rooms still had at least one of the 6 surfaces positive for at least one pathogen (6.0% of all surfaces were positive). This demonstrates that while manual cleaning and disinfection cut in half the number of surfaces that were positive for MRSA, VRE, or C. diff, the number of rooms that still contained some level

of these pathogens only reduced from 63.9% to 52.5%, suggesting the overall risk was not reduced to an acceptable level by manual cleaning and disinfection alone. Improvements in the cleaning compliance can be achieved by cleaning validation programs, but no studies have shown consistently high levels of compliance (i.e. over 90%) and the ability to maintain this level over time.

Emerging Technologies to Reduce Environmental Risk: Emerging technologies are being proposed for acute care facilities to help address environmental risk factors. Portable fogging solutions that use vaporized hydrogen peroxide and portable Ultraviolet-C (UV-C) units have been proposed. Weber (2016) published a literature review article on these "no touch" adjunct disinfection technologies, including UV-C systems, and concluded that these systems added value and decreased the risk of certain infections.

One of the challenges with emerging technologies in infection prevention and control is that high quality studies that conclusively demonstrate the value of the technology through clinical end-points, such as HAI rate reductions, are often not available for years after the technology is introduced to the market.

Studies on UV-C: Studies investigating the efficacy of new technologies typically go through a process where the first studies demonstrate efficacy in situ or in a simulated environment, then studies appear showing real world environmental impact, but using non-clinical indicators, such as bacteria counts on surfaces. If these two types of studies have been promising, eventually a well-designed multi-site study is performed that measures the impact on a clinical indicator, such as HAI rates. Healthcare facilities willingness to consider the technology is based in part on where they sit on the Rogers Innovation Adoption Curve (Dearing 2009), the perceived value of the innovation, and the depth of the available evidence.

There is significant evidence in the literature (50+ studies) that routine use of portable UV-C units can kill pathogenic microorganisms in laboratory conditions and when used on real world environmental surfaces (Weber, 2016). but when examined separately, the decrease was solely due to reductions in VRE, with no change in C. diff rates, and the changes in MRSA not being statistically significant. These studies demonstrate that while UV-C can have a positive impact on patient safety, there are also challenges in using UV-C to maximize its impact, and understanding how to optimize the performance of the UV-C unit may be as important as the use of the UV-C unit.

However, UV-C studies in the literature do not always show significant improvement in HAI rates. Pegues (2017) found a decrease in C. diff but no change in other HAI rates, including MRSA. Anderson (2017) found an overall decrease in MRSA, VRE, and C. diff rates, but when examined separately, the decrease was solely due to reductions in VRE, with no change in C. diff rates, and the changes in MRSA not being statistically significant. These studies demonstrate that while UV-C can have a positive impact on patient safety, there are also challenges in using UV-C to maximize its impact, and understanding how to optimize the performance of the UV-C unit may be as important as the use of the UV-C unit.

With only a few of the UV-C units on the market having been included in studies that showed a reduction in HAI rates and many studies showing variability in performance by pathogen, it is important to understand the factors which can improve or decrease the performance of a UV-C unit.

Challenges in Using UV-C: Anderson (2018) discusses the challenges they encountered in running their study. Among the operational issues or challenges identified were:

- Cycle aborted because room was needed immediately (N=906)
- Device malfunction (N=72)
- Missed opportunities due to device or personnel availability (N=30)
- High variability in cycle length (25 – 46 min for vegetative cycle and 41-71 min for sporicidal cycle)
- Needing to clean dust off the UV-C bulbs, which increased cycle run times
- Complaints of odor after UV-C use when staff entered room immediately after device use
- Malfunction of safety device resulting in nurse exposure to UV-C light

While there is no one solution to all these issues, the range of issues speaks to complexity in the use of a UV-C system and the importance in understanding the limits of the specific device being used. Boyce and Donskey (2019) published a review article on using UV-C units. Among the technical issues discussed were the following:

- UV-C light diminishes over distance (reduced by the inverse square of the distance), and thus having the unit closer to surfaces can improve efficacy. It is important to "Get the dose, close" to achieve maximum efficacy. It is important to "**Get the dose, close**" to achieve maximum efficacy.
- Line of sight (shadowing) reduces UV-C energy absorbed by a surface, so units run from multiple locations or with multiple light emitters can reduce the impact of shadowing. It is important to "**See the surface**" to achieve maximum efficacy.
- UV light can be UV-A (315-400 nm), UV-B (280-315 nm), and UV-C (100-280 nm). The peak efficacy is at 254 nm, so only UV-C light is biocide and units that produce UV-A and UV-B light are producing UV light that does not contribute to biocidal efficacy. UV units that consistently produce light in the 254 nm range will perform better, as this is the range of UV light that is the most biocidal. It is important to "**Be UV-C**" to achieve maximum efficacy.
- UV irradiance and the angle with which the UV-C light strikes a surface impacts the amount of energy absorbed by the surface. UV-C light striking a surface at a perpendicular angle (90°) results in the highest amount of absorbed light and the least reflected light. UV-C light striking a surface at a shallow angle results in most of the light being reflected and very little being absorbed. It is important for the surface to "**dose directly**" to achieve maximum efficacy.

Cadnum (2019) published a study comparing 8 different UV-C units, testing the amount of UV-A, UV-B, and UV-C light produced efficacy of each unit in a four-minute cycle. The study found significant differences in the amount of UV-C light generated by each unit and variation in the amount of efficacy each unit could achieve during the 4 min cycle on MRSA, VRE, and C. diff. However, all but one of the units achieved an acceptable reduction in the levels of MRSA, VRE, and C. diff, demonstrating that many of the devices on the market have the potential to be effective in a clinical environment.

Among the devices tested were Diversey's Moonbeam 3 (MB3), which has three adjustable arms to allow the UV-C light to be focused on areas of concern. It is notable that MB3 performed as well as the other units tested, which were primarily low pressure mercury tower devices, despite having substantially lower UV-C irradiance than the low pressure mercury tower devices. MB3 uses the articulation of the arms and the ability to direct the UV-C light to areas of concern to maximize the absorption of the UV-C light on surfaces, without "overdosing" surfaces, which may cause premature wear or discoloration.

Risks of Surface Damage: High output of UV-C light carries risks of surface damage for certain plastics. Many plastic surfaces can be damaged by repeated exposure to UV-C light. Surface damage on plastics is primarily determined by the total dose of UV-C energy delivered to the surface over its useful life. While a single cycle of a UV-C unit is not likely to cause substantial damage to surfaces, repeat usage of the UV-C device can cause damage over time. UV-C damage to surfaces can be seen as cracking, discoloration, increased brittleness, and hazing of clear plastics. UV-C units that are run from a single location in the room, or those that use substantially longer cycle times are at an elevated risk of causing surface damage to certain plastic surfaces, especially those closest to the UV-C unit, which absorb significant amounts of the UV-C light. based on angle of incidence. Total cycle length and UV-C energy delivery directly affect the potential for surface damage and should be a consideration when purchasing a UV-C unit.

Device Utilization: The UV-C unit only has an impact when it is being used. Studies such as Anderson (2018) showed that long cycles, significant variation in cycle time, and the size/storage of the unit can impact how frequently the device is being used.

Making the Best Choice: A number of factors are important to consider when selecting a UV-C unit. Below is a list of questions related to optimizing device utilization to consider when choosing a UV-C technology.

1. Will the turnover time associated with using the UV-C device fit the facility's peak needs so patients do not have to wait a long time for rooms to be cleaned?
2. How many patients are discharged each day at the facility?
3. Where will UV-C machines be used? For example, will they be used in the operating room or areas with higher risk patients, such as the intensive care unit?
4. How many machines should our facility purchase?
5. Where are the machines most needed in the hospital?
6. What does the cycle of completion, maintenance and audit look like for the machines?
7. Does the organization need to increase staffing to operate UV-C technology?
8. What types of education and training does staff need?
9. When is the best time to optimize UV-C disinfection? For example, should it be used after discharges, during the day or in procedure rooms and operating rooms at night?
10. How will the machines affect workflow in the system?

An understanding of the technical factors which drive the effectiveness of UV-C units is important in understanding how a given UV-C unit is likely to perform in the clinical environment. Below are considerations for optimizing the performance of UV-C units.

1. Consider the impact of placement of UV source in the room – to optimize the dose to surfaces and shorten cycle times, it is important to place the UV-C source within sight and ensure that the angle of light delivered can dose both horizontal and vertical surfaces. This may mean positioning the device in multiple locations, such as the patient care area and bathroom. Focus should be given to those areas or surfaces of greatest risk including surfaces nearest the patient, as well as high touch surfaces. This allows the greatest intensity of UV exposure to be applied to higher risk surfaces in the shortest amount of time.
2. The UV device should be stored as close to the point of need as possible. Significant time can be wasted porting the devices from one end of the hospital to the other. The reality is that if a UV device is not used because of logistic challenges, the benefit won't be realized.
3. To ensure cleaning schedules are consistent, create a spreadsheet listing who cleans what – e.g., who is responsible for cleaning the different pieces of equipment. This is often not established clearly.
4. To know what works for a given setting, hospitals can work with the UV-C machine manufacturer to evaluate the hospital's traditional workflow practice. In this way, hospitals can better identify how different types of rooms can incorporate UV disinfection.
5. Most manufacturers of UV devices have tested disinfecting results. This data can be reviewed to determine the efficacy of the devices. There is currently no standardized testing methodology for UV technology (Cadnum 2016), so data should be scrutinized to determine how the study was designed. Looking at the impact of distance, angle and soil on results are important considerations.
6. To measure how effective the device is at reducing contamination, hospital staff can culture surfaces before and after EVS staff manually disinfect a room, and then complete the same test after applying UV.

Staff can analyze changes between these results.

7. UV is a surface-only technology and is not an effective solution for soft surfaces, such as curtains. These surfaces still require a separate disinfection process.
8. Hospital staff should monitor the lifecycle of their UV light bulbs. The unit may or may not provide a warning when the bulb has been utilized for a long time and is approaching the end of its effective life. Some systems operate even with burned out bulbs providing, an ineffective disinfection cycle.

The Optimal Combination:

Improving the manual cleaning and disinfection process is important and should always be considered. At the same time, there are likely to be limits to the improvements in surface hygiene that can be achieved. The use of portable UV-C units can significantly improve environmental surface hygiene, build on improvements to manual cleaning and disinfection programs, and ultimately reduce HAI rates and improve patient safety. The combination of cleaning/disinfection and the use of UV-C can be an effective approach to environmental hygiene.

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TAKE 3 FOR ADDED ASSURANCE

Disinfect Horizontal AND Vertical High-touch Surfaces

3 INDIVIDUALLY ADJUSTABLE LIGHT ARMS

deliver a powerful, targeted dose of ultraviolet-C (UV-C) light directly to high-touch surfaces in the patient environment to reduce the spread of pathogens.

3 MINUTE FAST DISINFECTION CYCLES

Add effective assurance with seamless integration into the manual cleaning and disinfection process.

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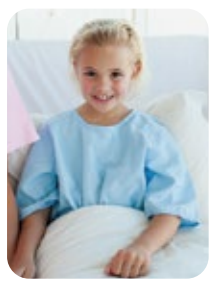
MoonBeam3 is simple to use, portable and affordable, so it can be used in more locations for patient safety and satisfaction.



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SEAL SHIELD™
Prevent Infections. Save Lives.

ElectroClave™ platform by Seal Shield™

Written by Christian Davis, VP of Technology & Product Development

ABSTRACT

The ElectroClave™ platform was developed by Seal Shield™ in response to US hospitals request to provide a comprehensive solution to properly manage and disinfect portable electronics throughout the entire system. Our advisory council made up of members from key organizations like Johns Hopkins, Yale New Haven, Kaiser Permanente, H Lee Moffitt Cancer Center, and Tulane University. All with similar concerns regarding key aspects around portable handheld electronics. The key concerns these organizations expressed were the following:

1. How can we properly disinfect portable electronics?
2. What should the policy be?
3. How do we ensure our users are compliant to the policy?
4. What actions are taken and by whom when devices are not compliant?
5. How do we charge our portable electronics?
6. How can we re-image/sync our portable electronics?

These problems identified by the council led to the development of the ElectroClave™ platform, which is a comprehensive portable handheld electronics disinfection solution. The ElectroClave™ is a scalable enterprise solution that provides 360° UV-C disinfection, smart charging, and device re-imaging/syncing combined with a SaaS-based software portal.

The software portal allows healthcare organizations the ability to manage custom workflows surrounding portable handheld electronics. The three key modules in the portal include Infection Control, IT, and Biomedical. Each of these modules brings features that solve key problems within each department respectively.

ELECTROCLAVE™ UV-C DISINFECTION - SSECLAVE4

UV Disinfection for Tablet Computers & Mobile Phones. LED UV-C Disinfection Cabinet with Smart Charging Technology. Disinfects/Charges 4 Tablets or 10 Phones at same time (device agnostic).

ElectroClave™ Feature & Benefits	Base	Silver	Gold	Platinum
Disinfection 360-degree disinfection, from rapid 60-second disinfection cycles to customizable cycles based on workflow and efficacy requirements, positive pressure dust free disinfection bays	✓	✓	✓	✓
USB Charge & Sync* 10 USB ports enabling smart charging and syncing (Syncing only allowed on Gold and Platinum packages)	✓*	✓*	✓	✓
Flexible Deployment Wall mount with locking feature, desktop mount with locking feature, interlocking and stackable to maximize space	✓	✓	✓	✓
Device Agnostic Multi-bay configurations to allow for multiple device form factors	✓	✓	✓	✓
Generic User Access Generic user access allows easy access by any user to the ElectroClave with a 4-digit PIN	✓	✓	✓	✓
Generic Badge Access Provide non-touch access to ElectroClave cabinets with NFC employee badges, supports both 125kHz and 13.56MHz	Optional	Optional	Optional	Optional
ElectroClave Status Monitoring Real-time indication of ElectroClave™ operation status and disinfection status throughout the organization		✓	✓	✓
Intelligent Maintenance Allows an organization to ensure greatest service up-time of ElectroClave through tracking and automated scheduling of services required		✓	✓	✓
Notifications/Alerts Provides customizable notifications/alerts via email and SMS to simplify the management of workflows		✓	✓	✓
Disinfection Usage Visibility on all completed disinfection cycles		✓	✓	✓
Unique User Access Gives organization the ability to provide individual user access			✓	✓
Employee Badge Access Provide non-touch access to ElectroClave cabinets with NFC employee badges, supports both 125kHz and 13.56MHz			Optional	Optional
RFID Tracking UHF RFID tracking that integrates to ElectroClave Portal and existing RFID infrastructures within organization			✓	✓
Disinfection Compliance Gives organization ability to establish, track and audit device and user compliance			✓	✓
Disinfection Mobile App Gives end users awareness of disinfection status and next disinfection cycle needed			Optional	Optional
Mobile Device Imaging/Syncing Over-the-wire syncing of phones or tablets through MDM				✓
Mobile Device Management Gives organization visibility on mobile device to user association, mobile device physical location, department allocation and facilitates HIPAA compliance				✓
System Integrations Ability to integrate to existing systems to include RTLS, EMR/EHR, MDM				✓

"The **lighting geometry** and placement of our **LED technology** allows for **360 degrees** of **disinfection** in each of our disinfection bays."

	IMPERIAL	METRIC
Dimensions	H: 16.8in D: 13.7in W: 15.7in	H: 427mm D: 348mm W: 400mm
Shipping Dimensions	H: 21.8in D: 18.5in W: 20in	H: 555mm D: 470mm W: 510mm
Unit Weight	34lbs	15.5Kgs
Shipping Weight	40lbs	18Kgs
Power Rating Input	AC 100-120 Vac, 50/60Hz, 3A AC 220-240 Vac, 50/60Hz, 2A	
Charging Voltage Output	5VDC, 2.4A	
Maximum Disinfection Cycles	2,000 hours	
LED UVC Disinfection Module Life	2,000 hours	
Disinfection Cycle Time all trays	1 minute – 14 minutes	
Disinfection Type	LED UVC Germicidal (No Chemicals)	
Disinfection Bay Sizes	9.843" x 10.945"	250mm x 278mm
Disinfection Bay Configurations	2 bays, 3 bays, 4 bays	
Storage Temperature Range	-4° F to 110° F	-20° C to 43° C
Operating Temperature Range	38° F to 90° F	3° C to 32° C
Operating Humidity Range	1% - 98% @ 80° F	1% - 98% @ 27° C
RFID Power Output Range	-5dBm to 30dBm	
RFID Regulatory	Pre-configured for the following regions: FCC (NA, SA), ETSI (EU, India), TRAI (India), KCC (Korea), ACMA (Australia), SRPC-MII (P.R. China), MIC (Japan), 'Open' (Customizable) 865-868 MHz and 902-928	
RFID Tags Type	Class 1 Generation 2 passive UHF RFID transponder	
NFC Card Reader Regulatory	Operating frequency 125kHz and 13.56 MHz	
NFC Card Types	https://www.rfideas.com/pcprox-plus-card-types	
WLAN Standard	IEEE 802.11 b/g/n	
WiFi Frequency Range	2.412GHz ~ 2.4835GHz (2.4GHz ISM Band)	
WiFi Number of Channels	11 for North America, 13 for Europe, and 14 for Japan	
WiFi Modulation	802.11b: DQPSK, DBPSK, CCK 802.11g/n: OFDM /64-QAM,16-QAM, QPSK, BPSK	
WiFi Data Rate	802.11b:1, 2, 5.5, 11Mbps 802.11g: 6, 9, 12, 18, 24, 36, 48, 54Mbps	
LWAD (1B=10 dB)	Operating 6.1B, Idling 6.0B	
LpAm (bystander positions)	Operating 55db, Idling 54dB	

For example, in the Infection Control module, a hospital can deploy specific disinfection policies to devices by location. Then, the portal manages the policies and takes action when devices are not in compliance. The IT module provides features like inventory management, device to user accountability, device usage by user, and asset allocation. Lastly, the Biomedical module gives institutions real-time predictability and maintenance functions. These give an edge to facilities to ensure that the solution has high availability to end-users in the field and predictable scheduling for operational maintenance.

SPECIFICATIONS

ElectroClave™ utilizes LED technology to produce UV-C wavelengths. We chose this technology above mercury-based lamps, both high pressure and low pressure, due to the ability to focus our energy in the most ideal UV-C germicidal wavelengths where peak inactivation of microorganisms occurs at 260nm1.

Additionally, our UV-C technology doesn't generate heat and degrade materials. We conducted third party analysis with Vocera™ to show that after one year of continuous exposure under our LEDs, their Vocera Badges had no material degradation. This analysis was performed using a thermogravimetric analysis at third party laboratory.

The lighting geometry and placement of our LED technology allows for 360 degrees of disinfection in each of our disinfection bays. The ElectroClave™ is also positive pressure and utilizes filtration media to prevent dust and particulates from entering the bays which leads to a decrease in efficacy because of shadowing. The disinfection bays are also equipped with quartz shelving to ensure no direct shadowing.

All of our disinfection cycles are tracked to the second and are smart algorithms correct for LED annealing over time to ensure the same dosage and efficacy is achieved whether the unit has run one cycle or 120,000 cycles.

METRICS (EFFICACY)

The ElectroClaveTM has undergone multiple efficacy studies with third party laboratories using the AOAC protocol to determine its efficacy against multiple pathogens. The efficacy achieved in one disinfection cycle on are below:

S. aureus ATCC 6538 > 99.99995%
E. coli ATCC 8739 > 99.9996%
S. aureus ATCC 33592 MRSA 99.98%
E. cloacae ATCC BAA-2468 CRE 99.98%

PRACTICE CHANGES

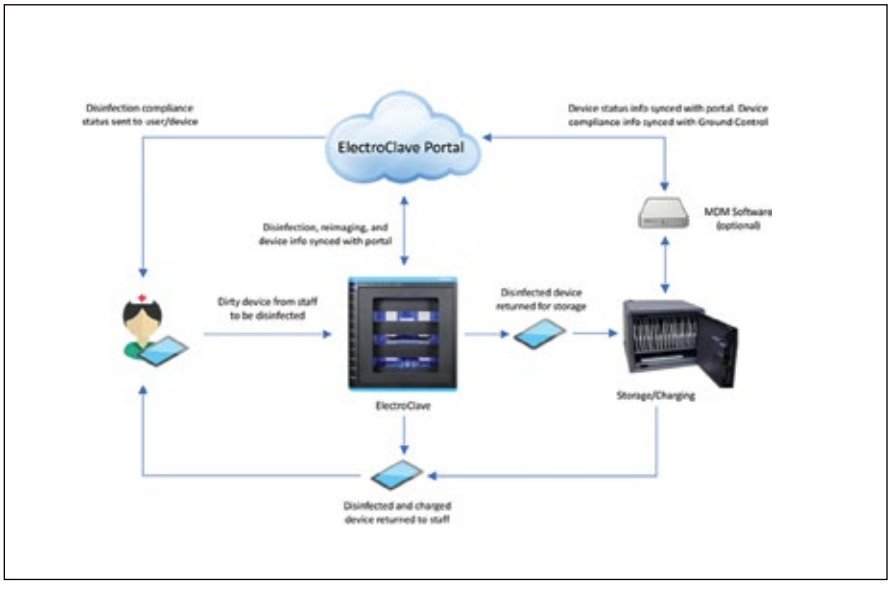
The ElectroClave™ solution is found across multiple departments within hospitals today. In our deployment, Seal Shield TM representatives identify and document the following by department:

1. Devices to be disinfected
2. Disinfection policies
3. Notification/alert triggers
4. User access both portal and ElectroClave™
5. RFID tag selection by device
6. Physical site integration
7. Network integration and security

These steps above vary depending on the licensing level the hospital selects with our platform. We have tiered offerings that range from a base level to a platinum level.

Physical deployment of the ElectroClave™ can be fixed with the capability of being locked as well as wall-mounted. In some situations, the device can be fixed to a mobile cart when mobility is needed, for example an emergency department.

The use of our solution is continuous. The room can be occupied while it is in use as the ElectroClave™ enclosure blocks UV-C exposure from an individual with mechanical and electronic fail safes. The ElectroClave™ allows visibility to which devices are in which disinfection bay while an active disinfection cycle is in process. Our disinfection cycles are configurable based on desired efficacy and typically range from 60 seconds to six minutes.



IMPLEMENTATION

The implementation process varies depending on the licensing level the hospital has selected. In our base level offering, the unit comes pre-configured with generic user access and is plug-n-play out of the box. Our Silver, Gold, and Platinum level offerings require onsite setup and configuration.

In all implementations, the stakeholders involved are typically the department head who is implementing the solution, IT, and infection control. Secondly, end users who will be using the ElectroClave™ to disinfect their portable electronics on a continuous basis. Lastly, any users that will be leveraging the portal for workflow automation, reporting, or tracking as the ElectroClave™ becomes an integrated part of daily operations will need to be involved.

With the built-in intelligent maintenance features of the ElectroClave, no additional steps are required to manage it on an ongoing basis. Disinfection module replacement is tracked with the software

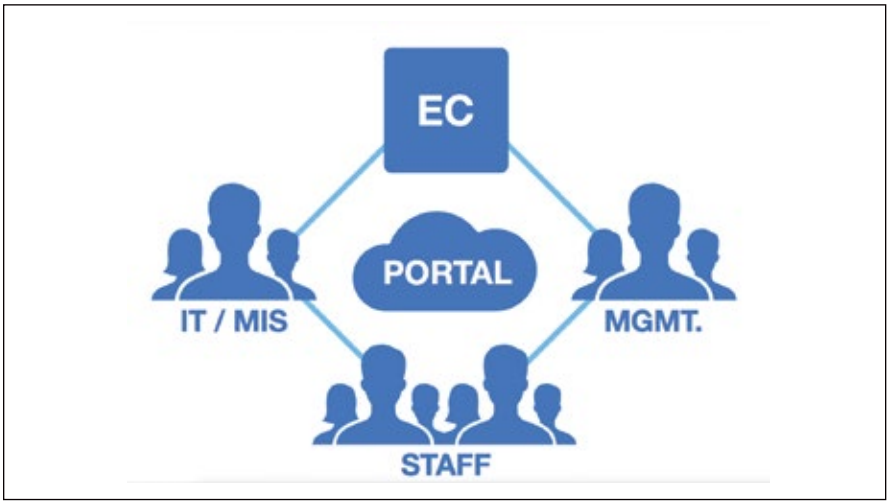
and when replacement is needed, alerts and notifications are sent to appropriate individuals whether that is done by hospital staff or a certified dealer. This prevents any down time of the unit because the replacement can be predicted ahead of time and properly scheduled to not impact end users.

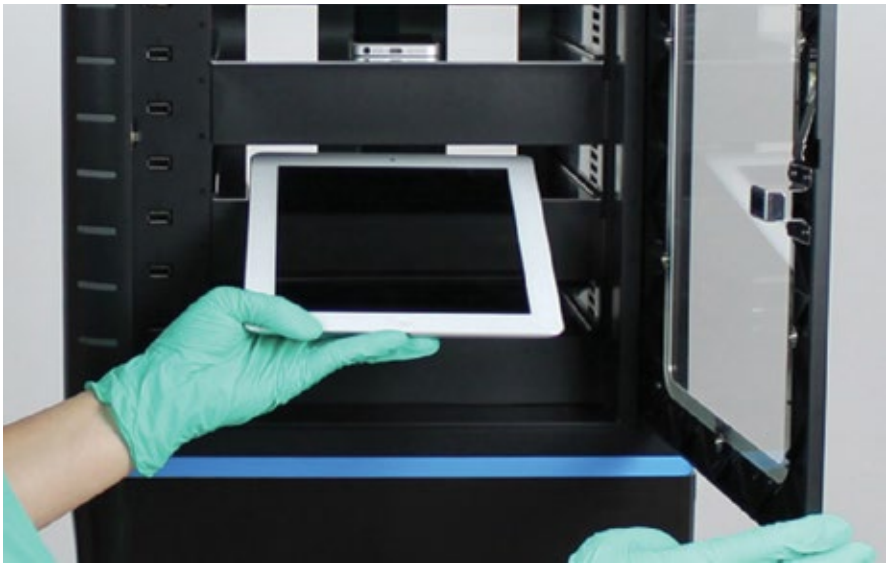
NARRATIVE

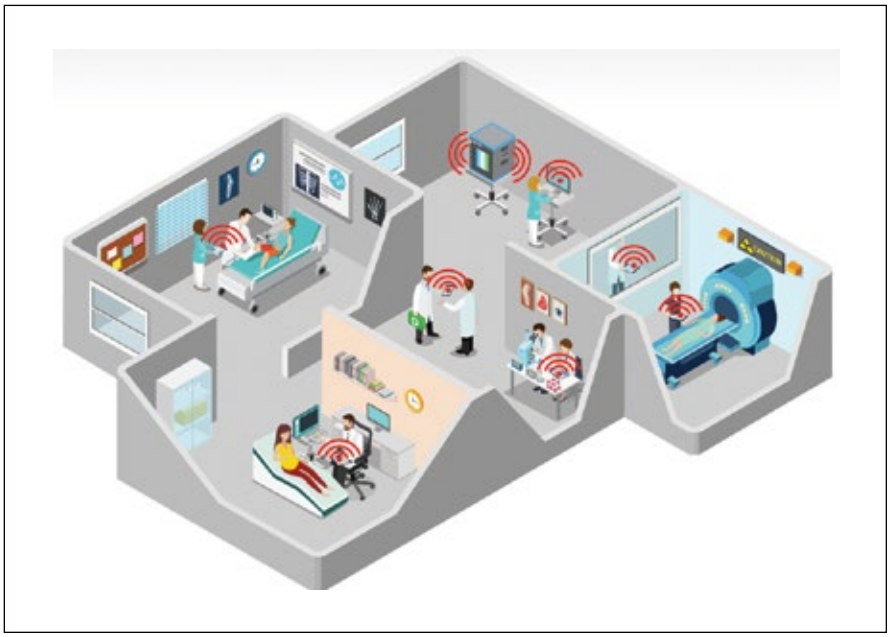
Implementations in the NICU have all visitors (staff included) placing their portable electronics in the ElectroClave while washing their hands. The ElectroClaves™ in the NICU are typically wall mounted above the hand washing area. While visitor's portable electronics are being disinfected, they wash their hands. By the time the visitors finish washing their hands, their portable electronics have finished a 60-second disinfection cycle. The visitors open the ElectroClave™, grab their portable electronic(s), and then enter the NICU.

This disinfection cycle is captured in the ElectroClave™ portal. Which then provides the necessary documentation so that the NICU manager and Infection Control Department can be assured that portable electronics are properly disinfected prior to entering the NICU.

If charging is needed on any of the visitor devices, those devices can be securely left in the ElectroClave™. If any of the devices that are corporate owned need to be re-imaged/synced that will occur as well when left in the ElectroClave™. The illustration below captures these varying workflows within the NICU as well as other departments like the OR, ICU, and ED.







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Keep Your Mobile Devices Clean and Protect Your Patients & Staff

Visit Now: http://www.sealshield.com (For More Info)

All-In-One Solution For Proper Disinfection of Handheld Electronics
96.2% of Phones Contain Bacterial Contamination

ElectroClave: An All-In-One Solution

The ElectroClave provides an all-in-one solution for 360 degree UVC-LED disinfection & Infection Preven-tion policy oversight by utilizing cloud-based mobile device management software. Seal Shield now has access to the singular enterprise solution that brings healthcare a way to standardize the disinfection of all portable electronics, with compliance reporting, compliance auditing, and validation.

The ElectroClave saves lives while increasing ROI:

- Mitigates risk of Hospital Acquired Infections (HAIs)/Surgical Site Infections (SSI)
- Increases practitioner's hand hygiene effectiveness
- Provides further visibility into staff, device, and patient interaction technology
- Prevents security breaches common with mobile technology

Mobile Technologies:

- Vocera Badges
- Tablets (iPads, Surface Pros, etc.)
- Handheld Scanners (Zebra, Honeywell, Datalogic, etc.)
- Smartphones (iOS, Androids, etc.)
- Two-way communication devices (Ascom, Voalte, etc.)
- Dictation Microphones

DISINFECTION MANAGEMENT

- **360 Degree UV-C Exposure**
- **Rapid Disinfection Cycles**
- **Adjustable Efficacy**
- **Compliance and Validity**

DEVICE MANAGEMENT

- **Device-to-User Accountablility**
- **Secured Inventory**
- **NFC Proximity Tap-N-Go Access**
- **Device Agnostic**
- **Multi Device Capacity**

Contact a Seal Shield Expert:
877-325-7443 (87-SEAL-SHIELD)

SEAL SHIELD™
Prevent Infections. Save Lives.

Prescient^{x} partners with Sanuvox Technologies Inc.

1. ABSTRACT:

In 2014, Prescient^{x} partnered with Sanuvox Technologies Inc., Canada's leading innovative UV manufacturer, to bring new UV technology to healthcare. Our Sanuvox UVC disinfection products for healthcare include: single and twin-tower mobile UV; UV HVAC coil cleaners; UV HVAC in-duct air disinfectors; and patient room air UV/filter disinfectors. But the most significant, award-winning, UV products are the AutoUV disinfectors, fixed devices built into the healthcare environment that provide autonomous disinfection.

We have achieved better understanding from recent studies of the patient's biome mirroring the organisms found in the inpatient room, which is constantly being seeded by staff, visitors, and other patients[1]. Dry biofilms persist on hospital surfaces re-seeding bacterial populations shortly after chemical disinfection. In one study, 93% of patient rooms failed the criteria of 2.5 CFU/cm2 when sampled two hours or more after daily cleaning[2]. Organisms can persist in the patient room days, weeks and sometimes months after a patient has been discharged.

Clean looking hospital surfaces typically measure 10 to 100 CFU/cm^2 of bacterial contamination. At this level of bioburden, models show there is a 40% chance bacteria will be transferred to hands or clothing with each touch[3]. Clinical staff touch an average of 15 objects with each patient visit[4]. At five patient visits per hour[5], it's no wonder up to 80% of disease transmission in hospital may be by touch.

It's time to deploy smart, autonomous, built-in AutoUV systems that can disinfect a room 10, 20, 30 times or more a day, provide repeated log2 to log3 bacterial reduction, maintaining a level of bioburden at or below 1 CFU/cm^2 [6]. At that level, the risk of bacterial transfer drops significantly. In fact, Quantitative Microbial Risk Assessment (QMRA) researchers at University of Arizona suggest this low level of bioburden reduces the risk of transfer of disease to just 1/1,000,000[7].

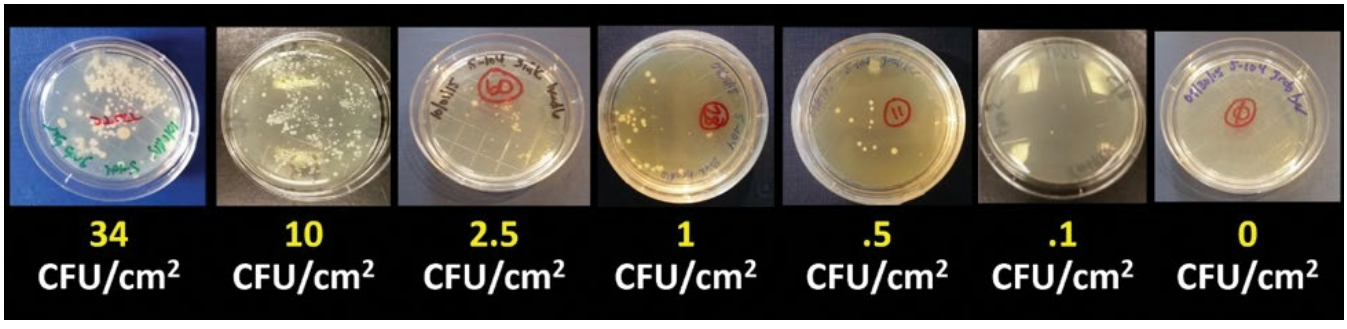
AutoUV is one of the three main pillars of Engineered Infection Prevention, aka the Self-Disinfecting Hospital, named a 2017 Top 10 World Patient Safety Innovation by the Patient Safety Movement. The concepts behind EIP include: autonomy, high-frequency/continuous, effective, and cost-effective bioburden reduction.

2. SPECIFICATIONS:

Asept.1x is a self-contained device providing 24/7 autonomous disinfection of bathrooms, utility rooms, and storage rooms. Asept.3x is a group of devices operating together to provide automated disinfection of complex environments like Patient Rooms.

Sanuvox UVC disinfection systems use high output 254 nm UVC lamps. UVC photons penetrate bacterial membranes and cause thymine molecules in DNA and RNA to bond, preventing replication. Bacteria and viruses have known but limited DNA/RNA repair mechanisms that are easily overwhelmed. Unlike antibiotics and chemical disinfectants, bacteria and viruses have not been shown to systematically develop further resistance to UVC.

Asept.1x – The world's first fully autonomous fixed AutoUV disinfector.



UVC disinfection constants have been published for most organisms allowing easy calculation of time and distance required for organism deactivation. In general, bacteria and viruses have little protection from UVC and may be deactivated in seconds, however, deactivation of bacteria in a spore state or deactivation of molds takes much longer than deactivation of vegetative bacteria.

UVC disinfection time varies directly with light intensity and varies inverse exponentially with the distance from the source to the target. If the emitter is two times closer to the target, the target receives four times the dose. Using two or more emitters together allows for reduced shadowing and increased line of sight. A target in shadow may require 10 to 20 times the disinfection time to achieve the same dose as a line of sight target.

3. METRICS:

The effectiveness of 254 nm germicidal UVC in reducing microbial contamination is well-known and is used throughout the world for water treatment, wastewater treatment, air treatment, food processing, etc. There are published 'k' values for hundreds of organisms detailing the UVC dose required for inactivation. The International Ultraviolet Association (IUVA), with the encouragement if the FDA and CDC, is currently developing a number of standards including test protocols for manufacturers to rate UV disinfection devices and to provide recommended best practices for healthcare. Dr. Curtis Donskey and Dr. John Boyce recently published "Understanding ultraviolet light surface decontamination in hospital rooms: A primer"[22] that provides further insight to new users of UV.

Environmental contamination in healthcare facilities leads to healthcare acquired infections (HAIs)[8-14]. The risk of acquiring an HAI increases when the prior room occupant has had an epidemiologically important HAI[15]. Mobile UV room disinfection at terminal discharge has been shown to be effective in reducing bacterial room contamination[16-18] and in reducing the overall rate of HAIs[18]. UVC terminal room disinfection was recently shown to reduce HAIs of patients exposed to prior room occupants with epidemiologically important HAIs by 32% and 37% over terminal cleaning with quaternary ammonium compounds and bleach alone, respectively[19].

Asept.3x – The world's first fully autonomous fixed AutoUV Patient Room disinfection system.

While there are many U.S.-based studies of mobile UVC devices for surface disinfection, studies of fixed, automated and autonomous UVC devices are more limited. Cooper et al showed a 97% reduction in bioburden using AutoUV in bathrooms [20]. Donskey et al showed that repeated UV disinfection doses in a bathroom environment are additive[21]. Hunt et al showed that in situ, compliance with closing doors was important to overall bioburden reduction. One-third door

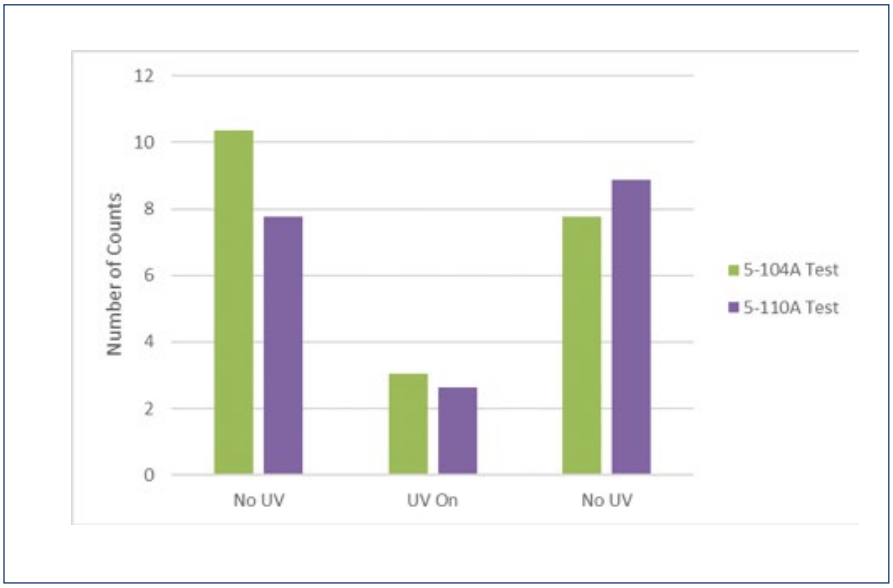
"While there are many **U.S.-based studies** of mobile UVC devices for surface disinfection, studies of **fixed, automated and autonomous UVC devices are more limited.** Cooper et al showed a 97% reduction in bioburden using AutoUV in bathrooms[20]."

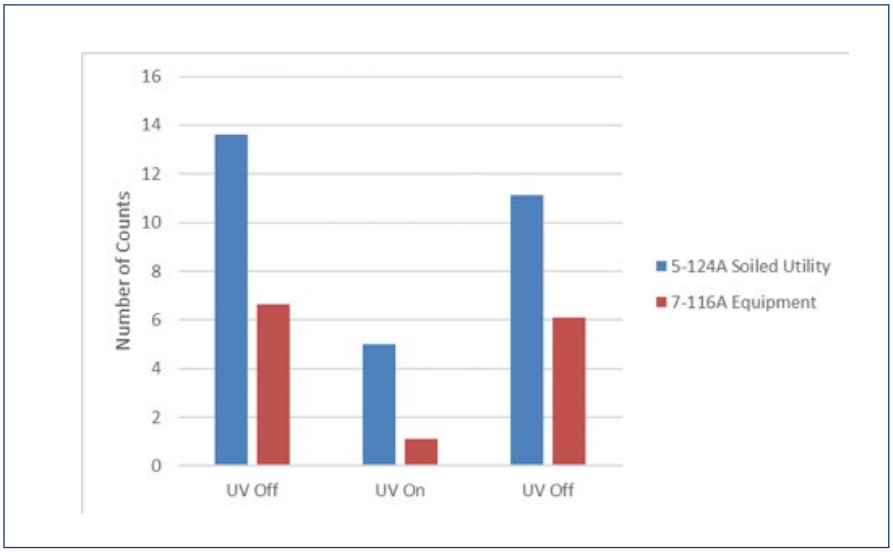
closing compliance led to achieving target bioburden reduction two-thirds of the time[6].

4. PRACTICE CHANGES:

Bathrooms – There are very few changes required to frontline practice when using fixed, autonomous UV bathroom disinfectors. The five-minute disinfection cycles are immediately interrupted if the door opens or if motion is detected by either one of two passive infrared detectors. The UV dose is additive, the more cycles the higher the UV dose, and the lower the overall bacterial contamination. In practice we found that even with signs posted, and a staff training program in effect, staff and patients do not always close the bathroom door upon exit. In an analysis of four years of data collected at one hospital, we found that compliance with door closure was only 20% to 25%. However, even this low compliance rate still provided surface bacterial reductions meeting our target of <1 CFU/cm^2 two-thirds of the time.

Patient Rooms – Integration of overhead UVC disinfectors into patient rooms allows immediate room disinfection with little, and potentially no, staff intervention. By simply entering a personnel-level code into a wired or wireless display, staff can initiate a disinfection cycle.





Graphs reproduced from Reduction of Hospital Environmental Contamination Using Automatic UV Room Disinfection[6].

Room	Average number of entries per day	Average number of UV disinfection events per day	Fraction of entries resulting in UV disinfection
Bathrooms 5-104A 5-110A	11.5 ± 6.1 9.3 ± 6.5	6 ± 5.5 3.4 ±3.1	0.44 0.32
SoiledUtility	70 ±13.0	18.9 ± 5.3	0.27
Equipment	55 ± 14.0	23.3 ± 5.5	0.44

Table from Reduction of Hospital Environmental Contamination Using Automatic UV Room Disinfection[6]

Patient Activation mode and Fully Autonomous mode are also available. To provide the additional safety required for these modalities, in addition to standard passive infrared sensors, an 'Eye-in-the-Sky' is deployed that uses machine vision, thermal imaging, and AI to track and monitor human activity in the patient room. The 'eye' communicates wirelessly with the disinfectors as well as a secure mesh network to provide data to a GDPR-compliant database.

Standard disinfection cycles are only five minutes long and can be interrupted at any time. This allows disinfection of an empty room when the patient goes to the bathroom, has a shower, goes for a walk, etc. Limiting disinfecting cycles to five minutes not only allows for normalized workflow, but also reduces the risk of exposure to UVC. One five-minute exposure would typically deliver a UVC dose less than or equal to the exposure limit recommended by NIOSH. However, multiple doses could cause photokeratinitis, a temporary itchy, scratchy, feeling in the eyes similar to welder's eye. Even higher doses could cause sunburn and repeated, chronic exposure to UVC may cause cancer. Therefore, as with all 254 nm UVC devices, rooms must be unoccupied when the AutoUV disinfector is in use.

5. IMPLEMENTATION:

Successful implementation of AutoUV for bathrooms and equipment rooms requires a technology champion as well as support from IPAC, EVS and Engineering/Facility Management. Patient Room AutoUV also requires participation and approval of IT to allow the wireless mesh network necessary to connect the 'Eye' to sensors, disinfectors and the internet.

The number and position of each overhead AutoUV device should be determined in consultation with Prescientx to ensure optimal results.

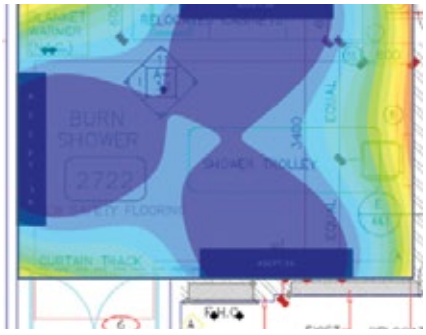
Once the decision is made to proceed, Prescientx will supervise and coordinate installation, start-up and commissioning, and staff training. Prescientx will also provide annual Preventive Maintenance that includes testing of operation and verification of lamp output of each installed unit. The healthcare facility will be required to ensure the lamps remain clean and dust-free. Prescient^{x} offers real-time monitoring and response to ensure continuous reliable operation.

6. NARRATIVE:

AutoUV has been successfully installed in hundreds of bathrooms, utility rooms and equipment rooms in dozens of hospitals in Canada. No IPAC, EVS or clinical staff are required for operation. Generally, installation is performed by electrical contractors for large installations and by in-house electrical staff for small installations. Ongoing maintenance is minimal, similar to traditional fluorescent light fixtures. Staff training includes safety education, signage, and top-of-mind focus for clinical staff to close bathroom doors to ensure multiple disinfection cycles every day.

AutoUV for Patient Rooms is new, currently deployed at just one hospital in Canada. Clinical or EVS staff initiate a five-minute disinfection cycle daily by entering a personnel-level code. A 20-minute disinfection cycle is performed at terminal discharge. The Hospital has not yet begun using Patient Activation or Fully Autonomous modes.

C. diff and VRE as well as respiratory viruses are shed in stool and are aerosolized with each toilet flush. There is a certain peace of mind knowing the bathrooms in a healthcare facility are being disinfected, automatically, six or more times per day. Likewise, equipment rooms, and all the patient care equipment in them, are being disinfected 20 or more times per day. And now, the technology exists to allow a patient to push a button and disinfect the own room. All without the need for staff intervention.



In future news, in collaboration with Sanuvox Technologies, Prescientx plans to launch Scarlett in 2020, our new autonomous mobile UV robot.

7. COST ESTIMATE:

Typical AutoUV for Bathrooms – $2,750 plus ~ $500 installation.
Typical AutoUV for Single Patient Room – $15,000 plus ~ $1,500 installation.
Basic Single Tower Pushbutton Mobile UV – $19,950 + annual operator costs
Platinum Single Tower Remote Start, WiFi Mobile UV w Reporting – $35,000 + annual operator costs
Platinum Twin Tower Remote Start, WiFi Mobile UV w Reporting – $55,000 + annual operator costs
Autonomous Mobile UV – $100,000 (estimated)

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WASTE MANAGEMENT

to be featured in the next *Industry Innovations*

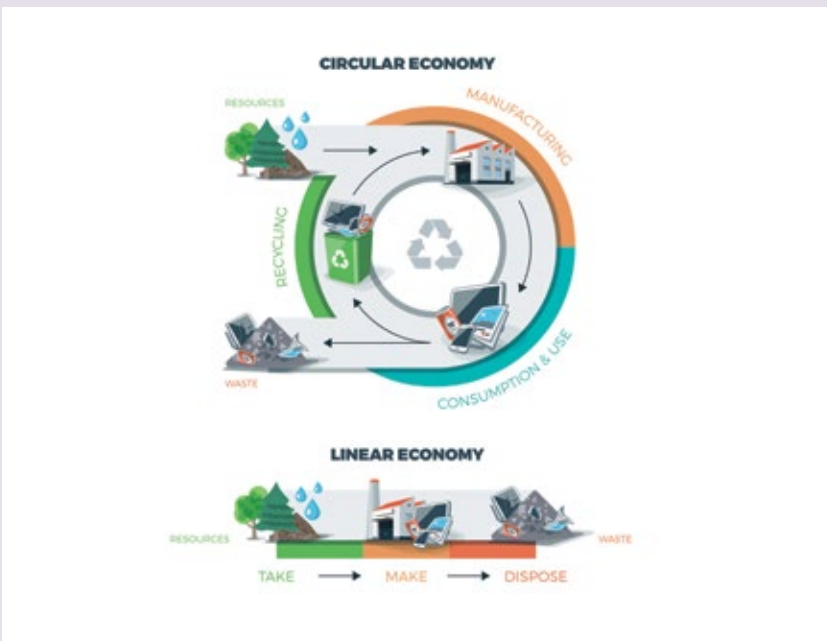
Industry Innovations will be back in Summer, 2020 showcasing innovative product offerings supporting our shared goal of infection prevention and control via Waste Management and Resource Stewardship.

In our best possible scenarios where we have effectively disinfected our environment of care, we may still lose control of source contaminants as waste travels through our facilities to its ultimate disposal. With all staff members contributing to waste production and management in some capacity, the implications of inadequate waste management to infection control and occupational health teams are unquestionable.

Emerging promotion of environmentalism through resource conservation and stewardship has begun tasking IPAC departments to perform ad-hoc evaluations of risks associated with waste reduction initiatives and scenarios for reuse of single-use products. When successful, these initiatives serve not only as success stories towards 'net-zero green hospital' initiatives, but serve to partially mitigate the enormous cost burdens of inventory management and waste disposal to healthcare facilities. IPAC attention to these initiatives is crucial to ensure that momentary cost savings and environmental stewardship in product use does not erode previous patient safety standards and controls. In my experience, projects attempting to minimize the hoarding of equipment in inpatient rooms have had the unfortunate byproduct of bringing administrative attention to the volume of product loss of unsealed or cardboard boxed items thrown out to adhere to IPAC best practices in terminal cleaning.

I am excited to see where industry partnerships in waste management can assist us in developing systems that minimize our risks of infection transmission through to the disposal of pathogenic waste from our facilities and evaluate our emerging role in ensuring we are making active strides toward resource stewardship without compromising the safety of our patients.

Thank you to IPAC Canada members for the continued opportunity to showcase our industry partners in this publication.



WASTE MANAGEMENT AND RESOURCE STEWARDSHIP GUIDELINES:

The role of the Editor, Industry Innovations is to ensure this publication is a high quality, structured, and comparative resource for Infection Prevention and Control Canada's (IPAC Canada) core membership. All submissions to Industry Innovations are subject to curatorial review. Relevance to IPAC Canada membership and integrity of claims will be assessed prior to approval or denial of publication partnership. For whitepapers accepted for publication, the editor will coordinate with the submitting industry partner prior to publication with applicable technical editing requests. The editor and publisher will ensure that the curation and publishing process of whitepapers and advertisements accepted for publication are managed transparently in consultation with authoring industry partners.

Preferred whitepapers for publication in Industry Innovations will refrain from subjective and unverifiable claims. They will use a mixture of industry voice, technical specification, and use-case logistics with significant attention to the immediate organizational impact of implementation. The numbered guideline sections below are sequentially ordered to provide a comparable reading flow throughout Industry Innovations volumes and must be adhered to during whitepaper development. The suggested word count is included for the whitepaper author's reference to ensure sufficient content is incorporated into each section without exceeding the suggested submission length of 4500 words.

GENERAL GUIDELINES:

- Core Focus: Industry Innovations' guidelines are structured to provide a comparable summary

of considerations to enable IPAC Canada readership to assess their organization's implementation readiness and the immediate use cases of an industry product
- Please refrain from comparing your product's solution to competing solutions
- Where clinical or industry research is referenced; ensure summary description of the research is included rather than generalizations

For in-text citations, use parenthetical numbers (Vancouver style) and append references to end of whitepaper using the same order of numbers appearing in-text

1. Abstract – ~500 Words:
- What makes this product stand out as an innovative solution to waste management in healthcare facilities?
  - Please refrain from comparative analysis to other innovations in waste management, but common standardized waste management processes may be referenced.

2. Specifications – ~600 Words:
- Describe the technology/engineering design of the waste management solution.
- If there are electronic components to the waste management solution, please describe their utility (sensor, tracking, cleaning, connectivity, etc).
- Describe any additional resources used peripherally to your product's waste management solution and what ongoing resources a healthcare facility implementing your solution will need to support ongoing waste management (e.g. on-site electrical power consumption, chemical or water input into device, storage/wall space, embedded into infrastructure, etc.).

3. Metrics – ~600 Words:
- Describe the recommended statistical tracking methodology for waste management with your product, as applicable (e.g. measurement of waste, recommended volume of waste retention with product, number of uses prior to discard, etc.).
- Previous quantitative research in effectiveness of the waste management solution may be described and referenced here.

4. Practice Changes – ~600 Words:
- Please describe the frontline practice changes involved in implementing your company's solution (not the overall impact of waste management, just the work involved with the product in use).
  - For example, will your solution add additional steps to nursing consultations/waste removal within the patient room? Will environmental services need to add another step to their workflow? Will clinical teams need to be trained to recognize the presence of the waste management solution?

5. Implementation – ~600 Words:
- Please describe the steps involved in implementation of your waste management solution.
- What stakeholders are needed (Environmental Services., Facilities/Maintenance, Infection Control, etc…)?
- What activities involved in initial implementation/ongoing maintenance of this waste management solution will be managed by your company?
- What initial/ongoing maintenance steps will be managed by the healthcare facility hosting your waste management solution?
- What maintenance steps are required to ensure the waste management solution is operating effectively on a continuous basis?

6. Narrative – ~700 words:
- Please provide in narrative format the post-implementation use-case of the waste management solution including a description of the waste production and management process using the product by healthcare staff and any new processes involved in the disposal of waste using the waste management product.
  - Please refrain from describing the general workflow of environmental services and facilities teams; focus on tasks performed by healthcare institution staff involving the immediate use of your product

7. Cost Estimate – ~300 words:
- Please provide a cost estimate in table format for implementation of your waste management solution given typical needs in a Small/Medium/Large healthcare setting

8. Contact Info – Please provide detailed contact info (phone, email, webpage, etc.) to ensure interested readers are able to reach out for further information and estimates.

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CHRONOS CHAMBER

- **Ultrafast** automated 180 seconds cycle time
- **Chemical free**
- **Disinfects cable and probe** further reducing cross-infection risk
- **No chemical residuals** left on the probe after disinfection cycle.
  - **No drying probe** removes the risk of cross contamination
  - **No gloves required and no chemical burns**
- **No hazardous fumes**
- **No extra steps** or phases in changing consumables, delay purge times or sleep modes
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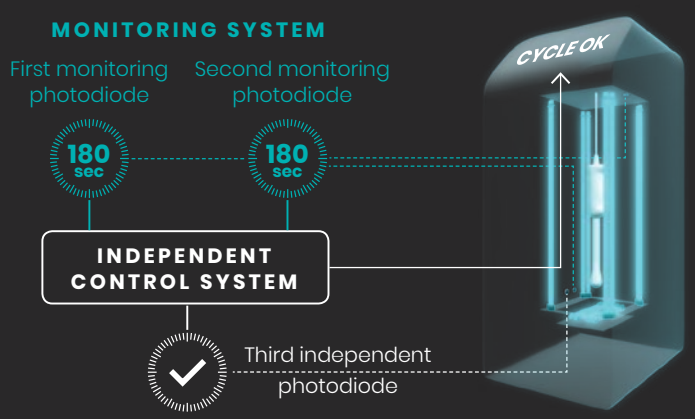
Germitrac® Automated Verification System

Replaces the manual process of checking chemical indicators and test strips.



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