Hospital Surface Disinfection Study

PART 2 OF 2: FULL REPORT*

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November, 2014

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Published January, 2015

Hospital Infection Control Challenges

There are billions of microscopic pathogens in hospitals—some harmful enough to cause serious diseases and even death, others just harmful enough to cause a bad case of the flu. The good news is, for those of us who are germaphobes, we can't see any of them. The bad news—neither can the people who clean the hospitals.

Hospital infection control practices are of supreme importance because they directly impact the health and safety of every person who enters those facilities—patients, visitors, and health care workers alike.

Hospitals are breeding grounds for dangerous and sometimes life-threatening microbes like HBV, HIV, MRSA, and tuberculosis, as these are the places where the most critically ill, infected, and injured people seek medical attention.

Hospital patients tend to have conditions such as compromised immune systems or open wounds from injuries, making them especially vulnerable to the dangerous microbes (pathogens) that live in hospitals.

Health care workers, unfortunately, are constantly exposed to both airborne and surface pathogens spread by infected patients. This exposure increases the chances that a healthcare worker will either become ill, or unknowingly spread these germs to others—both in and out of the hospital.

One out of every 25 patients who are admitted to a hospital will fall victim to an infection they pick up while there, according to the U.S. Centers for Disease Control and Prevention. These infections can be serious, even life-threatening, and incredibly costly. Recent studies have estimated that as many as half of them could be prevented if hospitals are being properly disinfected.

What Disinfectants Do

Disinfectants are antimicrobial agents that are applied to surfaces (such as door knobs, light switches and even hands) to destroy pathogens living on those surfaces. It's important to note that disinfection does not kill all microorganisms; the number destroyed depends on the quantity and quality of the disinfectant being used, as well as whether the disinfectant was used properly.

Disinfectants need to be applied to a surface and then left on that surface for a specific amount of time in order to work effectively. The amount of time a disinfectant has to stay on a surface to kill microbes is commonly referred to as contact time, dwell time, or kill time. Many consumers do not know that traditional disinfectants *generally* have a contact time of 10 minutes. Although many disinfectants start to work within seconds, to kill 99.9% of the bacteria and viruses (like many disinfectants claim to on their front product label), a full ten minute contact time is required. However, kills times can vary significantly based on how the disinfectant works. Most traditional disinfectants work by poisoning the microorganism from the inside over a relatively longer period of time—often up to ten minutes.

Chlorine dioxide (CD) works differently. It works by oxidizing the microbe, or destroying it from the outside. This mechanism of action has multiple advantages that will be discussed later.

*For a 2-page study overview, see: *"Hospital Disinfection Study: Part A: Overview & Highlights"*

Commonly Used Hospital Disinfectants

There are literally hundreds of EPA (Environmental Protection Agency) approved hospital disinfectants; the list is overwhelming to say the least. Most hospitals use quaternary ammonium-based disinfectants (quats) to clean and disinfect, primarily due to their widespread availability and relatively low price.

Although quats are commonly used in health care facilities, there are several major disadvantages to using them. One well-known challenge with quats is, that over time, they leave a sticky buildup on surfaces. That sticky residue actually attracts and harbors more dirt and microorganisms, making those surfaces even more difficult to clean and disinfect in the future.

In addition, when a quat is mixed with organic matter it loses its effectiveness. This makes it ineffective as a disinfectant in situations where blood, urine, or fecal matter are present—all of which are present in hospitals in both visible and microscopic amounts.

Several recent studies have also proven the challenge of "Quat Absorption" in which a quat's active ingredient becomes attracted to and absorbed into the fibers of the fabrics used to clean (e.g., wipes, towels, and mops). Because of this, less product is available to disinfect the surface, thus significantly reducing its efficacy.

Finally, quats typically have a 10-minute contact time, meaning they need to remain on the surface, *and wet,* for 10 minutes before being wiped off in order to kill the microbes.

Reason for the Study

To determine whether ProKure V, a chlorine dioxide-based disinfectant, was more effective at killing microbes[1] than the hospital's current disinfectant, a quaternary ammonium-based disinfectant.

Disinfectants Tested

The two disinfectants evaluated in this study were the hospital's current one-step disinfectant cleaner *(a widely-used quat whose brand name has been withheld for confidentiality purposes; hereafter referred to as "Quat X")* and ProKure V, an EPA registered, hospital-grade disinfectant, deodorizer, and sanitizer.

Chlorine dioxide (CD) has been used for years by water treatment plants to make drinking water safe for public consumption, used to disinfect fruits and vegetables, and used to sanitize the autoclaves that sterilize surgical instruments and laboratory equipment.

The hospital's current disinfectant has a 10-minute kill time; Independent laboratory tests show that ProKure V starts killing in 10 seconds and kills the murine norovirus (a surrogate for human norovirus in virucidal efficacy evaluations) in 30 seconds.

Hospital Areas Surveyed & Process Used

Two main areas of the hospital were surveyed: operating rooms and patient rooms in the Intensive Care Unit (ICU). Ideally, these two areas should be microbe-free due to the critical nature of the patients being treated in these areas.

All rooms were terminally cleaned[2] using either the hospital's disinfectant, Quat X, or ProKure V using the hospital's standard cleaning protocol. Each surface area being surveyed was cleaned with 100% polypropylene wipes that had been saturated with either Quat X or ProKure V.

In each room, high touch areas such as bed rails, door knobs, etc., were swabbed and cultured *after* the rooms had been cleaned to determine the amount of microbes still present. All target sites being surveyed (bed rails, door knobs) within the rooms were swabbed with RODAC[3] plates (petri dishes) three times. This was to ensure an adequate sample size. The RODAC plates were then incubated for 48 hours at 37° Celsius—the optimal temperature at which microbes grow in the human body. In all, 108 different

	hospital surfaces were cleaned, swabbed, and cultured; each of those surfaces in triplicate, resulting in a sample size of 324 RODAC plates. Each plate was then examined for microbe counts.
Study Administration	The study was conducted in a well-known hospital in Phoenix, Arizona. Maurice Croteau, CEH, HEM, an independent third-party surveyor, conducted the study. All aspects of the study were witnessed by Mr. Croteau and the hospital's Environmental Services Supervisor. The rooms were cleaned by the hospital's Environmental Services (EVS) Techs following standard procedures. Mr. Croteau observed the cleaning of all rooms to ensure the correct disinfectant was used in each room.
Key Findings	This study demonstrated that ProKure V was much more effective at disinfecting microbe-dense areas in a hospital than the quat-based disinfectant. **ProKure V yielded impressive and superior results, significantly outperforming Quat X. A staggering 96% of culture plate samples from the rooms cleaned with ProKure V showed lower levels of microbes than the samples from the rooms cleaned with Quat X.** After only one application, ProKure V reduced microbe counts by over 51% in operating rooms and over 69% in patient rooms, respectively, compared to rooms cleaned with Quat X *after only one use*. Although these are impressive results, it is important to note that significant build up existed on all surfaces tested from the extended use of Quat X (which is a common problem associated with quats). Any surface buildup is likely to invite additional microbial growth, making it more difficult for a disinfectant to work properly. To fully demonstrate the benefits of a CD-based disinfectant over a quat-based disinfectant, the product needs to be applied more than one time in order to remove the existing build-up. Mr. Croteau believes that if the residue on the tested substances had not been present, the ProKure V disinfectant would have yielded even more impressive results.
Additional Findings	During this study, Mr. Croteau decided to have the EVS Techs also test ProKure V in the restrooms to observe what impact it would have on odor control. Although using ProKure V to eliminate odors was not the primary reason for the study, all parties noticed an immediate and significant reduction in unpleasant odors for a sustained period of time. In fact, when Mr. Croteau returned to the hospital four days later, the restrooms cleaned with ProKure V were still odor-free. In contrast, Quat X has yet to yield any reduction in unpleasant odors, per the EVS Techs and the Environmental Service Supervisor.
Benefits of Chlorine Dioxide (CD)	CD is so effective and so strong it kills anthrax, Ebola, and norovirus—some of the most lethal and hard-to-kill pathogens. CD gas is already used in hospital autoclaves to sterilize medical instruments and laboratory equipment, but CD in liquid form can be just as effective as the gas. There are a myriad of benefits to using a CD-based liquid disinfect, too numerous to list in this specific study. For hospitals and health care facilities in particular, there are four primary benefits: 1. First, CD is extremely powerful and fast because of the way it works. CD works by destroying the physical structure of the cell membrane from the outside in through oxidation, unlike most other disinfectants that work by poisoning the cell from the inside out. In essence, CD works faster because the speed of kill is determined by oxidation, which happens within seconds, rather than waiting on the organism to ingest and metabolize the disinfectant, which takes quite a bit longer. 2. Second, because of the way CD works and the speed of kill, it prevents microorganisms from adapting and building up resistance. With traditional disinfectants that take longer to work, if the disinfectant solution is too weak, if the

surfaces does not stay wet long enough, and/or if the organism is too complex, it will not die. This means that the exposed organism, when it reproduces, can build up a resistance. This is especially important for healthcare settings seeing an increased number of bacterial adaptation and antibiotic-resistant pathogens.

3. Next, not only is CD faster and more effective than quats, it's probably the safest disinfectant that exists. In fact, CD is so safe, that in lower concentrations it is used to sanitize water, bleach flour, keep fruits and vegetables bacteria-free, and is put in mouthwashes and toothpastes to help eliminate bacteria on the teeth and gums.
4. Finally, CD leaves behind no harmful residue or build-up on any surface. *In effect, it disinfects and then disappears*. This is important for several reasons:
    A. When there is no build-up, there is nothing for microbes to attach to, decreasing the likelihood of future surface contamination.
    B. When there is no build-up, the disinfectant can better eradicate microbe as there is nothing for it to "work through."

Final Considerations

If you have ever been in a hospital as a patient, or you have sat by the bedside of a loved-one, you know countless questions run through your mind: *"Does my doctor know what she's doing? Will the nursing staff take good care of me? Will I be able to pay my medical bills after I leave?*" and the list goes on. Worrying about whether you, or a loved one, is coming into contact with dangerous pathogens should be nowhere on that list.

Given the fact that the highest cost component of cleaning and disinfecting a hospital is labor, why would hospital administrators compromise on the quality of the disinfectant solution being used? Why would hospitals choose an inferior disinfectant when a more effective, safer alternative product exists?

When it comes to solving the complex problem of infection control in hospitals, using ProKure V is the best solution. Literally. ProKure V is faster, stronger, and safer than any other disinfectant being used in hospitals today.

While it is unrealistic to expect hospital environmental services supervisors to walk around with petri dishes and microscopes to ensure surfaces are being properly disinfected, it is realistic to expect them to explore the use of ProKure V.

Healthcare consumers, healthcare workers, and emergency responders—such as police officers, firefighters, and EMTs—should expect hospital administrators to do their due diligence when selecting products used to clean, sanitize, and disinfect hospitals. In short, CD kills microbes better and faster than quat disinfectants, as validated by this study, and documented in numerous scientific publications.

Unfortunately while we cannot choose which disinfectant is used by the hospitals we end up in, we can, and should, urge hospital administrators to conduct their own disinfectant effectiveness study—testing the efficacy of their current disinfectant against that of ProKure V. The results will speak for themselves. Besides, there's nothing for them to lose other than a few billion microbes…

ENDNOTES

[1] A pathogen is a microbe that has the potential to cause disease. For purposes of this study, we are using the terms microbes and pathogens interchangeably because patients in intensive care and operating rooms are those most susceptible to infection and illness. The main objective of this study was to quantify the number of microorganisms present in ICU patient rooms and operating rooms, not identify those microorganisms.
[2] Terminal cleaning consists of cleaning all surfaces and fixtures in restrooms and cleaning of walls, windows, ceilings, removal of the sharps containers, dusting, vacuuming and mopping.
[3]RODAC stands for Replicate Organism Detection and Counting. The plates are essentially petri dishes that you press against a surface. Any microbes on that surface adhere to the RODAC plate.

Appendix A

Post Disinfection Results

Plate Photos

Exhibit 1: Disinfection Plate Count Comparison Between Quat X and ProKure V

Actual Plates from ICU Patient Room Bedrails

Surface Cleaned with Quat X | **Surface Cleaned with ProKure™ V**

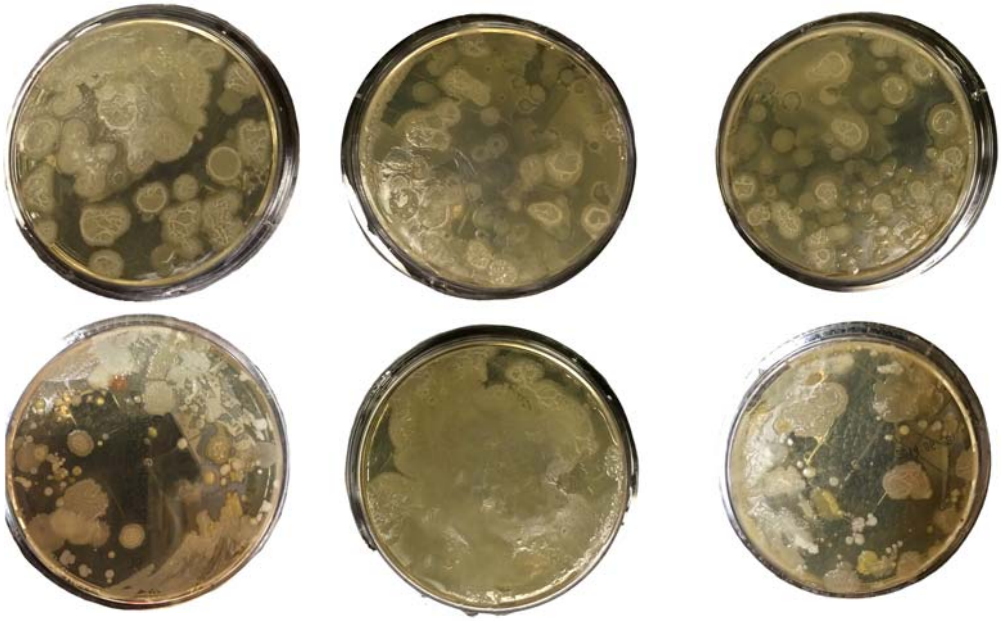
Exhibit 2: Quat X Disinfection Plate Samples

On 18 surfaces cleaned with Quat X, pathogen plate counts were so high, they could not be counted. Those plates were classified as *Too Numerous to Count* or "TNTC" In contrast, not one surface cleaned with ProKure V returned TNTC plate counts. Below are some images of the TNTC plates from surfaces cleaned with Quat X.

More Plate Samples from Surfaces Cleaned with Quat X…

All plates to the right are from surfaces cleaned with Quat X.

18 surfaces cleaned with Quat X returned results similar to these.



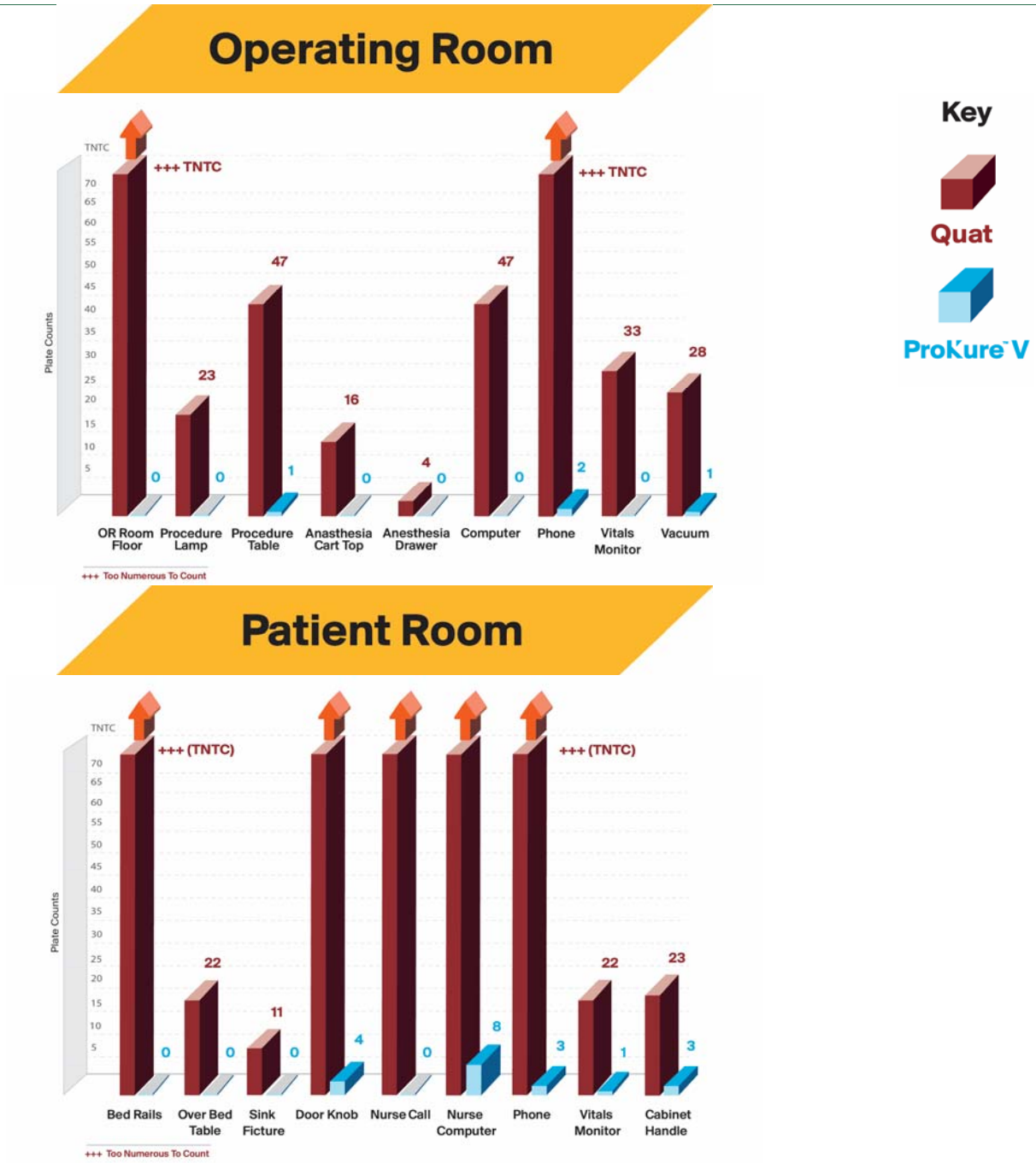
In contrast, no surfaces cleaned with ProKure V that looked like these.

Appendix B

Post Disinfection Results

Highest Quat X & Lowest ProKure Plate Counts

The graphs below display the highest count of microbes detected on those substances that were cleaned with Quat X and the lowest number of microbes on surfaces cleaned with ProKure V. The reason these graphs are important is that they show the power of ProKure V to completely eliminate microbes after only one use. They also show "*what is*" versus "*what could be*" if the hospital were to switch disinfectants.

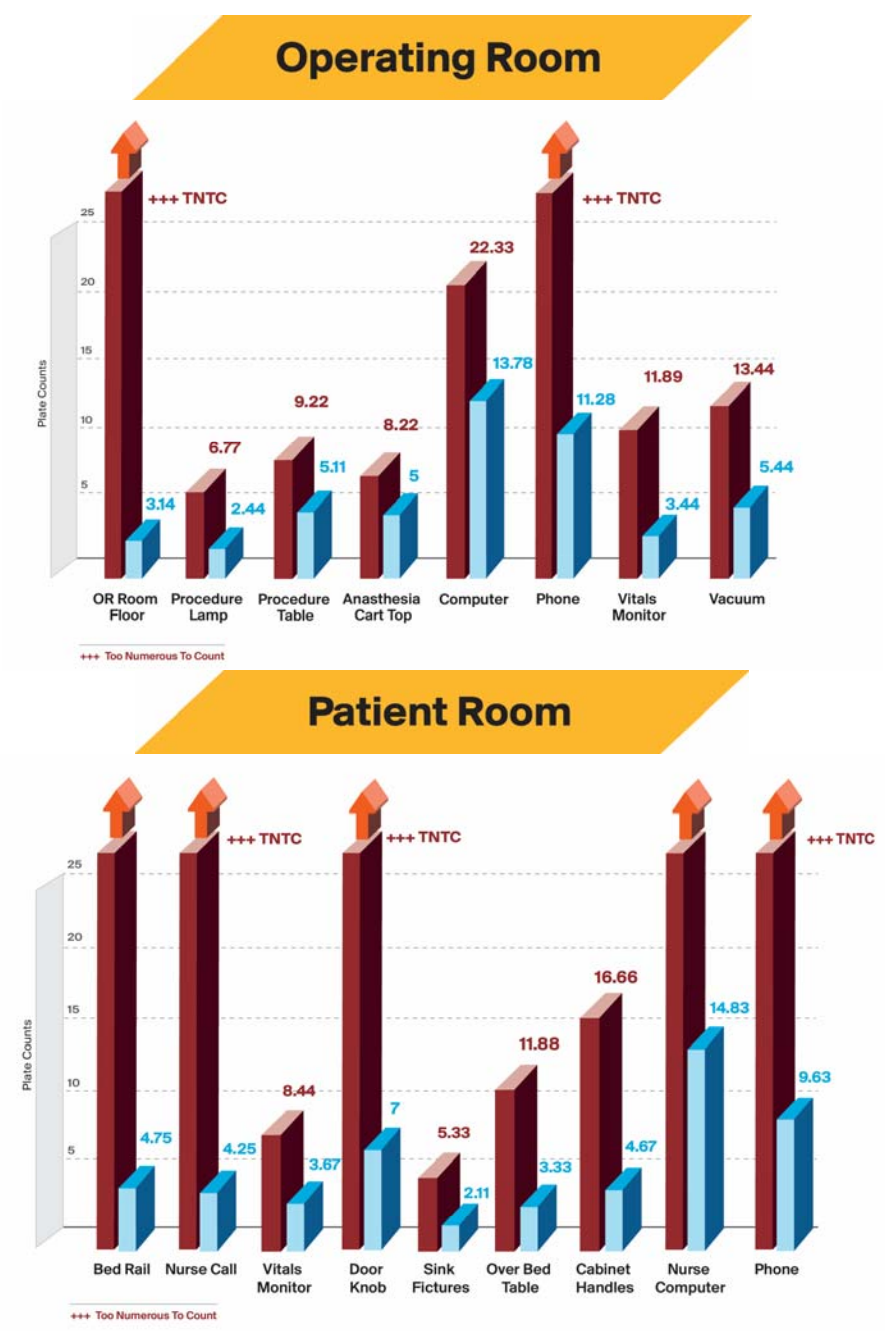


Appendix C

Post Disinfection Results

Average Plate Counts

Important: After only one use, ProKure V reduced pathogen count by an average of 51% in the operating rooms and almost 70% in the patient rooms over Quat X. However, there was significant residual build-up on all surfaces tested from the extended us of Quat X. Quat-based disinfectants are known to leave surfactant residue, which can actually invite more microbial growth and inhibit disinfection. While it is evident that ProKure V was much more effective at disinfecting, Mr. Croteau believes that if the residue on the tested surfaces had not been present, ProKure V would have yielded even more impressive results. In fact, in numerous areas, ProKure V eliminated all pathogen growth, demonstrating its full power.



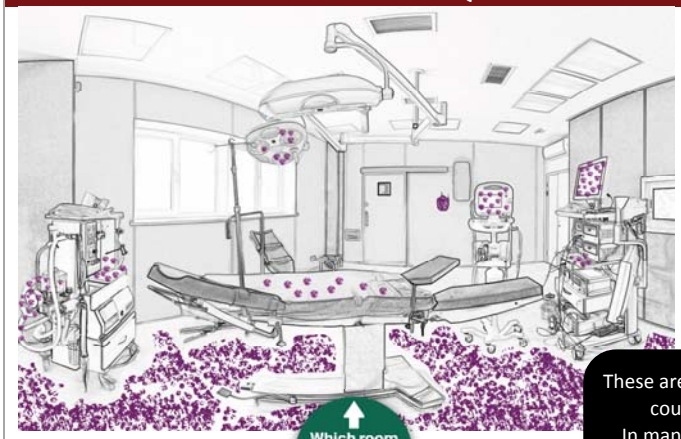
Appendix D

Post Disinfection Results

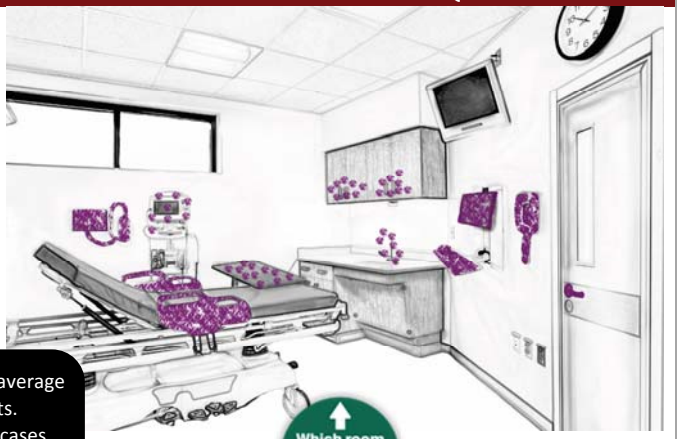
Microorganism Heat Maps

The illustrations below visually represent the average number of microorganisms detected on those substances cleaned with Quat X versus the number detected on surfaces cleaned with ProKure V. It's important to note that these are averages, and that on numerous surface areas, ProKure V was able to able to eliminate all microorganisms (See Appendices E & F for surfaces where all microbes were destroyed).

Operating Room
Post Disinfection with Quat X

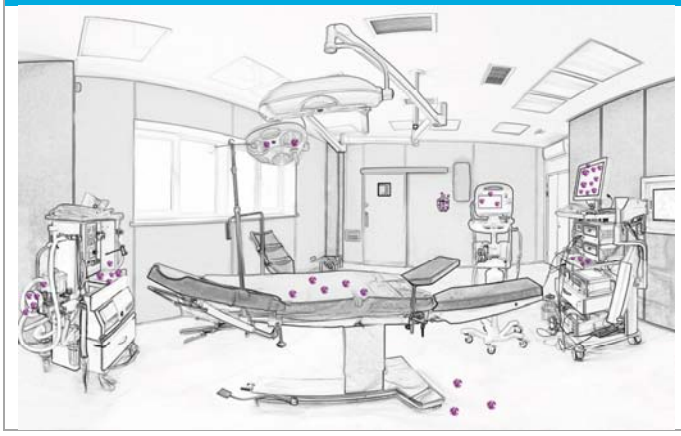


ICU Patient Room
Post Disinfection with Quat X

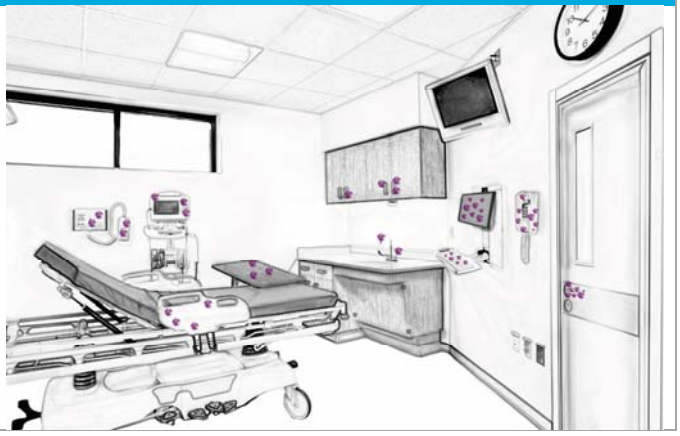


These are average counts. In many cases ProKure V left surfaces pathogen-free after only one use.

Operating Room
Post Disinfection with ProKure™ V



ICU Patient Room
Post Disinfection with ProKure™ V



Appendix E

Post Disinfection Results

Operating Room Plate Counts

The tables below display all plate counts post disinfection using either Quat X or ProKure V. As evidenced below, those surfaces cleaned by ProKure V had substantially lower levels of microbe counts; a higher number of surfaces that were completely microbe free, and no incidents where microbe counts were too numerous to count (TNTC).

Quat X Results

Operating Room 1

Target Area	Plate Counts		
FLOOR	TNTC	TNTC	42
PROCEDURE LAMP	6	0	7
PROCEDURE TABLE	47	7	15
ANESTHETIA CART TOP	2	9	16
ANESTHESIA DRAWER	3	4	4
COMPUTER	12	20	18
PHONE	9	4	11
VITALS MONITOR	11	3	12
VACUUM	1	9	19

Operating Room 3

Target Area	Plate Counts		
FLOOR	17	28	5
PROCEDURE LAMP	3	3	4
PROCEDURE TABLE	0	2	1
ANESTHETIA CART TOP	5	13	3
ANESTHESIA DRAWER	2	0	0
COMPUTER	6	47	5
PHONE	14	42	2
VITALS MONITOR	33	10	6
VACUUM	11	28	19

Operating Room 5

Target Area	Plate Counts		
FLOOR	7	29	13
PROCEDURE LAMP	23	10	5
PROCEDURE TABLE	9	2	0
ANESTHETIA CART TOP	5	12	9
ANESTHESIA DRAWER	2	0	0
COMPUTER	26	47	20
PHONE	5	TNTC	TNTC
VITALS MONITOR	13	11	8
VACUUM	9	13	12

ProKure V Results

Operating Room 2

Target Area	Plate Counts		
FLOOR	0	7	13
PROCEDURE LAMP	2	0	5
PROCEDURE TABLE	11	1	3
ANESTHETIA CART TOP	4	2	2
ANESTHESIA DRAWER	4	19	5
COMPUTER	18	11	19
PHONE	11	3	33
VITALS MONITOR	7	3	12
VACUUM	2	7	11

Operating Room 4

Target Area	Plate Counts		
FLOOR	1	4	11
PROCEDURE LAMP	5	3	0
PROCEDURE TABLE	1	19	3
ANESTHETIA CART TOP	10	11	9
ANESTHESIA DRAWER	4	9	2
COMPUTER	10	0	16
PHONE	11	12	17
VITALS MONITOR	1	2	3
VACUUM	9	4	9

Operating Room 6

Target Area	Plate Counts		
FLOOR	2	1	3
PROCEDURE LAMP	2	5	0
PROCEDURE TABLE	1	4	3
ANESTHETIA CART TOP	1	6	0
ANESTHESIA DRAWER	0	0	0
COMPUTER	10	8	32
PHONE	11	9	2
VITALS MONITOR	1	2	0
VACUUM	1	5	1

Appendix F

Post Disinfection Results

ICU Patient Room Plate Counts

The tables below display all plate counts post disinfection using either Quat X or ProKure V. As evidenced below, those surfaces cleaned by ProKure V had substantially lower levels of microbe counts; a higher number of surfaces that were completely microbe free, and no incidents where microbe counts were too numerous to count (TNTC).

Quat X Results

Intensive Care Patient Room 1

Target Area	Plate Counts		
BED RAIL	8	17	20
OVER BED TABLE	11	7	8
SINK FIXTURE	2	0	9
DOOR	34	TNTC	TNTC
NURSE CALL	TNTC	8	16
COMPUTER	28	16	TNTC
PHONE	24	9	TNTC
VITALS MONITOR	1	0	22
CABINET	16	13	20

Intensive Care Patient Room 6

Target Area	Plate Counts		
BED RAIL	41	22	30
OVER BED TABLE	5	10	16
SINK FIXTURE	7	11	2
DOOR	TNTC	TNTC	TNTC
NURSE CALL	23	11	14
COMPUTER	TNTC	58	TNTC
PHONE	27	19	31
VITALS MONITOR	8	12	4
CABINET	15	22	11

Intensive Care Patient Room 10

Target Area	Plate Counts		
BED RAIL	50	42	TNTC
OVER BED TABLE	12	16	22
SINK FIXTURE	3	9	5
DOOR	TNTC	TNTC	TNTC
NURSE CALL	32	24	19
COMPUTER	36	12	55
PHONE	12	27	41
VITALS MONITOR	9	8	12
CABINET	16	23	14

ProKure V Results

Intensive Care Patient Room 2

Target Area	Plate Counts		
BED RAIL	4	11	7
OVER BED TABLE	1	2	5
SINK FIXTURE	4	7	2
DOOR	7	10	15
NURSE CALL	1	9	7
COMPUTER	18	37	22
PHONE	3	16	11
VITALS MONITOR	11	5	4
CABINET	3	4	8

Intensive Care Patient Room 7

Target Area	Plate Counts		
BED RAIL	0	4	1
OVER BED TABLE	0	1	4
SINK FIXTURE	1	0	3
DOOR	6	4	11
NURSE CALL	2	0	2
COMPUTER	12	19	8
PHONE	8	3	5
VITALS MONITOR	2	4	1
CABINET	2	2	4

Intensive Care Patient Room 11

Target Area	Plate Counts		
BED RAIL	7	12	4
OVER BED TABLE	8	3	6
SINK FIXTURE	0	1	1
DOOR	12	10	6
NURSE CALL	0	3	19
COMPUTER	12	18	11
PHONE	16	11	20
VITALS MONITOR	1	3	2
CABINET	3	9	7