



**WHITE PAPER PREPARED FOR
XANITOS, INC.**

**THE CASE FOR XANITOS'
XRO SYSTEM IN REDUCING
HOSPITAL ACQUIRED INFECTIONS**

August 11, 2009

The Case for the Xanitos XRO™ System in Reducing HAIs

I. Introduction

Environmental contamination is increasingly recognized as a contributor to hospital-acquired infections (HAIs). As a result, cleaning methods and quality are getting increasing scrutiny by hospital infection control officers, as well as by senior hospital administrators, as an important part of hospital infection control. Xanitos has developed a proprietary method of cleaning: the XRO™ System. The Company believes that the XRO™ System can provide significant reduction in disease-causing pathogens in comparison to cleaning methods currently in use in US hospitals. Additionally, the Company believes that it can contribute far more to the reduction of HAIs than competitive environmental cleaning services due to the combination of its XRO™ System, its unwavering focus on quality, and its commitment to ongoing staff training.

This paper is divided into five sections. Section II discusses the relationship between environmental contamination and HAIs. Section III describes the Xanitos XRO™ System, compares it to conventional cleaning methods in existence today in US hospitals, and summarizes relevant studies published in peer-reviewed literature. Section IV describes anecdotal data gathered by Xanitos on the XRO™ System, and Section V contains the conclusion and recommendations.

II. Evidence of environmental contamination as a contributor to HAIs

As described in some detail below, pathogens responsible for a variety of nosocomial infections have been found on almost every environmental surface in hospitals, although the link between the presence of these pathogens and HAIs is not necessarily obvious as disease transmission has multiple potential routes.

S. Huang et al¹ in a twenty-month retrospective study of patients admitted to eight (8) intensive care units at Brigham and Women's Hospital (~ 10,500 ICU patient-days) showed that admission to a room *previously occupied* by a MRSA-positive or VRE-positive patient significantly increased the odds for acquisition of MRSA and VRE despite room cleaning methods that exceed national standards. Among patients whose prior room occupant was MRSA-positive, 3.9% acquired MRSA versus 2.9% of patients whose prior room occupant was MRSA-negative (Adjusted odds ratio, 1.4, p=.04). Among patients whose prior room occupant was VRE-positive, 4.5% acquired VRE versus 2.8% of patients whose prior room occupant was VRE-negative (Adjusted odds ratio, 1.4, p=.04).

In another paper, D. Kumari et al² traced an outbreak of MRSA at a UK hospital to ventilation grilles in an orthopedic ward. Six patients and one nurse were involved in an outbreak of EMRSA-15 during March 1996. The index case was a transfer from another hospital. One of the patients shared the same bay with the index patient; the rest had no

direct contact with the patient. An environmental source was suspected and the ventilation grilles in both the bay where the index patient resided, as well as the bay where the other five patients resided were found to be harboring EMRSA-15.

Rampling et al³, in a paper reporting the results of a study on the relationship of hospital hygiene to control of MRSA in a hospital in the UK, found that prior to intervention that outbreak MRSA was found on roughly 10% of environmental surfaces cultured. Environmental surfaces cultured included furniture, floors, flat surfaces, door handles, ventilation ducts/grilles, and medical equipment. After an intervention that focused on improved environmental cleaning in September 1999, the number of outbreak MRSA was reduced from 69 in the 21 month period prior to intervention to three in the six-month period following intervention. Additionally, post-intervention, monthly surveys of outbreak MRSA failed to detect this strain on environmental surfaces. The intervention included the following: (i) routine housekeeping was increased by a factor of two, with emphasis on dust-control by *vacuum cleaning of carpets and vinyl floors*, (ii) bed curtains were laundered every three months or more frequently if soiled, (iii) Radiators and ventilation grilles were cleaned every six-months by hospital maintenance staff, and (iv) routine cleaning of all shared medical equipment (e.g., drip stands, suction equipment, etc.) was set-up. Ratula concludes, “Thorough and continuous attention to ward-hygiene and *removal of dust* was needed to terminate a prolonged outbreak of MRSA infection on a general surgical ward, in addition to standard infection control measures. Control of hospital-acquired infection with MRSA requires a combination of measures, none of which are completely effective in isolation.”

Hota⁴ in a review article on the relationship between environment and nosocomial infections concludes that, “Despite documentation that the inanimate hospital environment becomes contaminated with nosocomial pathogens, the data that suggest contaminated fomites lead to nosocomial infections do so indirectly. Pathogens for which there is more-compelling evidence of survival in environmental reservoirs include *Clostridium difficile*, vancomycin-resistant enterococci, and methicillin-resistant *Staphylococcus aureus*, and pathogens for which there is evidence of probable survival in environmental reservoirs include norovirus, influenza virus, severe acute respiratory syndrome-associated coronavirus and *Candida* species.”

Kramer et al⁵ on a review of the literature of the survival of pathogens on inanimate surfaces reports that (i) most gram-positive bacteria, such as *Enterococcus* (including VRE), *Staphylococcus aureus* (including MRSA), and *Streptococcus pyogenes*, survive for months on dry surfaces, (ii) many gram negative species can also survive for months, (iii) most viruses from the respiratory tract can persist for several days, and (iv) viruses from the gastrointestinal tract persist for approximately two months.

III. Elements of the XRO™ System that reduce HAIs

The XRO™ System includes the following elements:

- Daily use of double HEPA-filtered vacuum cleaners to remove dust and pathogens from floors, other horizontal surfaces, air vents and TV sets
- Daily mopping of floors with single-use (e.g., one mop head per room) microfiber mops, pre-soaked in clean water and Neutral Cleaner, to remove dirt and pathogens attached to floors
- Wiping of touch-points with single-use microfiber cloths, pre-soaked in germicidal solution, two-times per day
- Use of HEPA-filters on buffing machines to prevent dust (and pathogens) removed from floors from being released into the air.
- Proper care and cleaning of microfiber mops and micro-fiber cloths to ensure on-going effectiveness
- Educating housekeeping staff on its role in the prevention of deaths and illness by HAIs, and on-going training of housekeeping staff on proper cleaning techniques

Each of these elements are discussed in relation to their importance in reduction of HAIs and contrasted to conventional methods of cleaning.

Use of double HEPA-filtered vacuum cleaners to remove dust and pathogen from floors and other horizontal surfaces

The heart of the XRO™ System is a double HEPA-filtered mobile central vacuum that removes dust and other particulate matter from the floor and other horizontal surfaces—both high and low. The Xanitos XRO™ System provides for daily vacuuming of floors, vents, furniture, and TVs. Utilizing a brush cleaning attachment, high surfaces (vents, TVs, etc.) and furniture are vacuumed first. After these surfaces are vacuumed, the brush cleaning attachment is removed and replaced with the floor attachment, and the floor is then vacuumed. The bathroom, both floor (providing it is dry) and high surfaces, are also vacuumed daily (with the appropriate attachments) after the patient room is vacuumed. The brush cleaning attachment is disinfected between each room.

Xanitos believes that removing dust and particulate matter is an important part of infection control. In contrast, conventional methods of cleaning floor (e.g., use of a dust control tool then mopping with a wet mop and detergent but without a disinfectant) are, at best, only marginally effective in removing dust and fine particulate matter. Indeed, dust with conventional cleaning methods tend to be dispersed, initially over a patient room and ultimately from room to room.

Many of the pathogens associated with nosocomial infections have been found in dust⁶.

According to S.J. Dancer⁷, a microbiologist, with regard to *C. difficile* spores, “Vacuuming up dust from floors is probably one of the simplest methods to remove spores from the environment. Buffing and mopping may only serve to spread them around an even wider area.”

A clear benefit of the XRO™ System is that the system provides for daily vacuuming of dust from ceiling and wall vents not just floors. Contaminated vents have been implicated in the spread of MRSA and other nosocomial infections. In contrast, conventional cleaning approaches provide for the cleaning of vents by the maintenance staff, at best, once a month, but, more typically, once every six months if not less often.

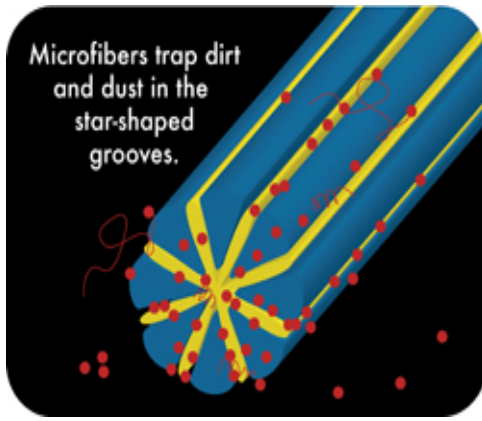
The potential benefit of vacuuming to remove dust, debris, and potentially pathogen spores is underscored in a paper by T. Sexton et al⁸. Prior to the daily cleaning, six horizontal surfaces (bed-frame, the mattress, bed linen, bedside table, the chair, and window ledge) were sampled in the isolation rooms of 25 MRSA patients. Additionally, three settle-plates were left in the room for 2 hours (one each placed on the floor, the bed-table, and window ledge). Additionally, air samples were taken. A high proportion of samples taken were positive for MRSA: 53.6% surface samples, 28% air samples, and 40.6% settle plates. Identical or closely related isolates were recovered from the patient and their environment in 70% of the sample taken, suggesting possible environmental contamination of the isolation rooms.

Although the Sexton paper dealt with MRSA, given the ability of most viruses and bacteria associated with nosocomial infection, to exist in a dry environment for days (if not months), it is fair to extrapolate that other pathogens are effectively being released into the environment by such afflicted patients.

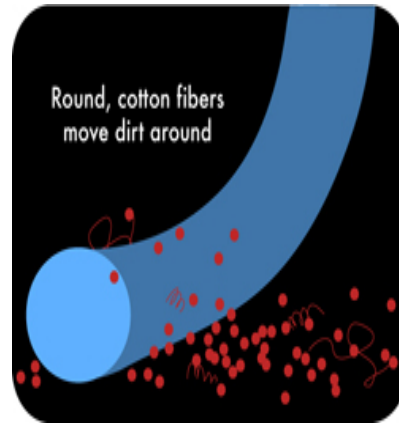
Mopping of floors with clean single-use microfiber mops pre-soaked in Neutral Cleaner

The XRO™ System provides for daily mopping of the patient room floors with a *single-use microfiber* mop presoaked in *clean-water* and Neutral Cleaner (a detergent). Microfibers are densely constructed synthetic (typically either polyester or polyamide) fibers with diameters of 10 microns or less, approximately 1% of that of a human hair. It is far more absorbent⁹ than the conventional loop mop, being able to hold six times its weight in water, due to its high ratio of surface area to volume. Even more important is its superior ability to remove dust and other debris (including pathogen spores) from surfaces. The small diameter of the microfibers allows their penetration into the microscopic pores of most surfaces- allowing for superior dust and debris removal. Additionally, there is also an electrostatic cleaning effect. Dust and most pathogens, being negatively charged, are electrostatically attracted to the positively-charged microfibers.

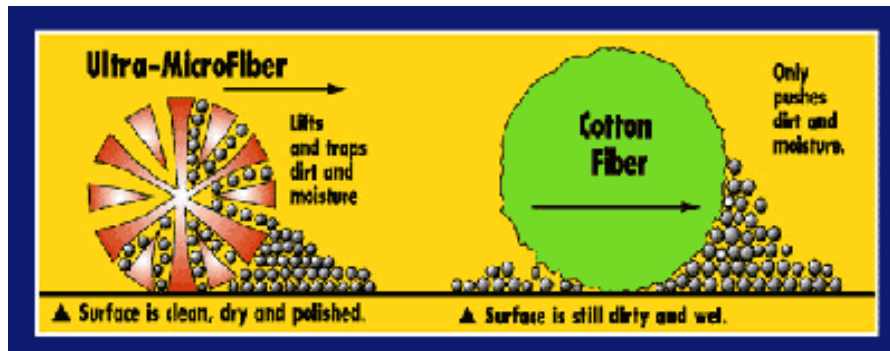
A microfiber mop (or cloth) can also hold significantly more dirt¹⁰ than a cotton cloth. Microfibers trap dirt in the star-shaped grooves, whereas cotton fibers tend to push dirt around!



Microfiber



Cotton Fiber



Microfibers provide far more surface area
(charts provided by Elizabeth P. Easter, PhD, University of Kentucky)

In the XRO™ System, after a patient’s room is vacuumed, one member of the three-person cleaning team comes in with a mop with a fresh-microfiber mop-head, pre-soaked in clean water and Neutral Cleaner (e.g., a detergent) and mops the floor. Large rooms often require two mop-heads per room. After the floor is mopped, the housekeeper removes the microfiber mop-head and drops it in the “Dirty Bucket” on the cart and attaches a new pre-soaked microfiber mop-head for the next room. A fresh microfiber mop-head pre-soaked in clean water and Neutral Cleaner essentially eliminates the possibility of room-to-room cross-infection by cleaning.

In contrast, under conventional mopping techniques (using either a cotton mop or a microfiber mop with bucket with wringer), the housekeeper dunks the mop in a bucket of water with detergent, mops the floor, wrings the mop into the bucket to remove dirty

water picked up by the mop, and re-dunks the mop into bucket to wet it again. The process is repeated until the floor of the entire room is mopped. The housekeeper then moves to the next room with the same bucket and repeats the process. Hospital procedures typically call for the bucket to be emptied and refilled with clean solution every 3-4 rooms.

Obvious potential concerns with conventional mopping techniques, at least where a disinfectant is not used, are that (a) pathogens rather than being removed from the floor are distributed over a wider area and (b) pathogens are inadvertently transmitted from room-to-room with contaminated mop water. The literature strongly supports these potential concerns. Another practical concern is that if the disinfectant solution is not changed frequently (every two to three patient rooms) the solution itself becomes contaminated causing bacteria to be added to rather than removed from later rooms.

Exner et al¹¹ developed a new test method to allow a comparison of various cleaning methods and disinfectants in reducing microbial loads and in disseminating such microbials to prior clean areas. His test method provided for the contamination of one area (5 cmX 5cm) with 0.5 ml pf *S. aureus* (3×10^7 cfu/ml), mopping that area as well as three other originally non-contaminated adjacent areas (each 5 cmX5cm and separated by a 7 cm gap from one square to the next), and then measuring the bacterial load on the originally contaminated square as well as the three adjacent squares. Under these test conditions, Exner showed that water alone and water with surfactants each reduced the bacterial load by somewhat more than 100-fold in the contaminated square but that the three adjacent squares were contaminated to approximately the same level as "Square 1". Cleaning with glycol derivatives and glycol derivatives and quaternary ammonium compounds showed about a 100-fold improvement but similar results in terms of cross-contamination of adjacent squares. Aldehydes and peroxides showed a 10^5 fold reduction and no dissemination of S.A. to adjacent squares.

Ratula et al¹² contrasted the effectiveness in removing microorganisms from floors under three scenarios: (i) cotton mop/ standard bucket with wringer, (ii) microfiber mop/ standard bucket with wringer, and (iii) micro-fiber mop with a customized rinsing system. Two sets of tests were done, one with just detergent (Neutral Cleaner from Ecolab) and one with a disinfectant (QUAT). In the set of tests using detergent, the microfiber mop with the customized rinsing system performed significantly better than either of the other two approaches, removing 95% of the micro-organisms versus 80% for the micro-fiber mop/ standard bucket with wringer and 68% for the cotton mop/ standard bucket with wringer.

Xanitos believes that if the XRO™ System were to be tested against any of the three methods described by Ratula, it would perform far better than even the most effective method used by Ratula (e.g., microfiber mop with customized rinsing). The XRO™ System has one important pre-step: the rooms are pre-vacuumed, minimizing the likelihood of the microfiber head becoming saturated with dust. Still another advantage of the XRO™ System is that a fresh clean microfiber mop-head (vis a vis Ratula's customized rinsing system) is used for each room.

Ratula also showed that with the micro-fiber mop with the customized rinsing system only, disinfectant did not improve micro-organism removal effectiveness from that with detergent (both 95% removal). On the other hand, he showed that disinfectant significantly improved the micro-organism removal effectiveness of microfiber mop/ standard bucket with wringer (87% removal) and the cotton mop/ standard bucket with wringer (95% removal).

Ratula further showed that the cotton mop/ standard bucket with wringer *with disinfectant* and the micro-fiber mop with the customized rinsing system *without disinfectant* performed identically, both removing 95% of the micro-organisms. Although from the point of view of micro-organism removal effectiveness, the cotton mop/ standard bucket with wringer and *with disinfectant* was shown to be equal to the microfiber mop with the customized rinsing system *without disinfectant*, the results are somewhat academic as routine daily use of disinfectants is not practical. Not only do disinfectants tend to leave a film and hence are associated with poor cosmetic results, but there are increasing reports of allergic reactions to disinfectants by healthcare workers. Additionally, there are significant environmental concerns with the flushing of disinfectants into our nation's sewage systems, as well as concern that wholesale use of disinfectants might cause many pathogens¹³ to mutate and develop immunity towards various disinfectants. For that reason, judicious and limited use of disinfectants is generally encouraged.

Dharan et al¹⁴ compared various cleaning protocols of ward floors in University Hospitals of Geneva. The four protocols included cleaning with (i) a mop and detergent solution, (ii) a “dust-attracting disposable dry mop”, (iii) a mop and an active oxygen based (AOB) compound, and (iv) a mop with quaternary ammonium (QA) compound. The mops had a reservoir to hold detergent or disinfectant. Measuring bacterial surface contamination before and after cleaning, he found that (i) ward floors cleaned with water and detergent actually showed *an increase* in bacteria count, (ii) ward floors cleaned with QA showed no change in bacteria count, and (iii) both the “dust-attracting mop” and the mop with AOB showed an approximate equal reduction in bacteria count. Dharan concludes that with detergent and water, “We were introducing bacteria into patients’ environment” thorough the use of “contaminated water”. The XRO™ System of cleaning floors in patient rooms first through removal of dust with a vacuum and then followed by subsequent mopping with a single-use microfiber mop with detergent should yield even better results than Dharan’s “dust-attracting disposable dry mop” and far better results than a mop and detergent solution. By use of a fresh, pre-soaked microfiber mop for each room, the XRO System solves the “contaminated water” problem.

Wiping of surfaces with single-use microfiber cloths, pre-soaked in germicidal solution, two times per day!

Daily (or more often) cleaning of touch points is an important tool to reduce HAIs. This point is well illustrated by a paper by Barker et al¹⁵, in a study highlighting the chain of pathogen transmission back and forth from dirty hand to clean environment and dirty

environment to clean hand. This study, utilizing a reverse transcriptase polymerase chain reaction assay, showed that fingers in contact with Norovirus (NV)-infected fecal matter is consistently spread via fingers to melamine surfaces and from there to the usual hand-contact surfaces: water taps, door knobs, telephone receivers, etc. He also showed that NV can be transferred up to seven times by clean fingers touching a contaminated surface and then touching and (and hence contaminating) a second initially-clean surface. Although NV is notorious for being difficult to kill, the ease at which pathogens can be spread back and forth from environmental surfaces to hands undoubtedly holds true for many of the other pathogens responsible for nosocomial infections.

As part of the daily cleaning under the XRO™ System, all patient contact surfaces (bed-table, bedside table, phone, chairs, low ledges and counter, light switches, door knob, faucet handles, TV remote, and bed-control switch) are wiped with a microfiber cleaning cloth presoaked in germicide (Virex). A similar process is repeated in the bathrooms, but with a second microfiber cloth (of a different color). In the bathroom, the mirror, grab bars, dispensers, sink fixtures, basin, underside and pipes, shower fixtures, toilet fixtures, seat and base are wiped down. In addition to the morning cleaning, the touch-points, in both patient rooms and patient bathrooms, are cleaned a second time through the Xanitos Evening “Freshen-up” service.

The more conventional approach in US hospitals is to wipe the touch-points with a cotton cloth (as opposed to a microfiber cloth) and disinfectant once per day (as opposed to twice a day under the Xanitos XRO™ System). Additionally, the same benefits of microfiber mops vis a vis cotton mops also accrue to microfiber cloths (e.g., its greater ability to remove and hold dirt compared to cotton cloths).

Xanitos believes that its twice daily cleaning of touch-points may provide a very significant advantage in reducing HAIs than once-daily cleaning, as is the convention in most US hospitals. Extrapolating the results of the study by Hota (ref 16) in which he show a 6% significant decrease in VRE for an 10% increase in number of patient touch-points cleaned, cleaning touch points twice a day could potentially decrease VRE by over 50%. In addition to this paper by Hota, there are numerous papers that strongly suggest that cleaning of environmental surfaces could help reduce HAIs.

Dharan et al¹¹ compared various cleaning protocols of furniture (presumably hard-surface furniture only) in University Hospitals of Geneva. The three protocols included cleaning with (i) a cloth and detergent solution, (ii) a “dust-attracting disposable” cloth with detergent, and (iii) a cloth and an active oxygen based (AOB) compound. Comparing bacterial counts before and after cleaning, he found that furniture, as like floors, cleaned with cloth and detergent showed an increase in bacteria account, but the “dust-attracting disposable” cloth with detergent and the cloth with AOB showed an equal reduction in bacteria count.

Ray et al¹⁶ report that investigators acquired VRE nearly half the time after contacting colonized patients’ bed-rails and bedside tables *without direct patient contact*. In a

similar report, Boyce et al¹⁷ demonstrated the acquisition of MRSA on nurses' gloves by touching surfaces near colonized patients but not direct contact with patients.

Bhalla et al¹⁸ examined the frequency of acquisition of bacterial pathogens after contact with environmental surfaces (but not direct patient contact!) near patients in single-patient rooms on 8 wards (3 medical wards, 1 geriatrics ward, 1 spinal injury ward, a hemodialysis unit, 1 MICU, and 1 SICU). Specimens were obtained prior to admission of the patient but after the room had been terminally-cleaned using standard hospital protocol. All control hand imprint cultures performed prior to contact with surfaces were negative. Hand imprint cultures were positive for one or more pathogens after contacting surfaces near patients 53% of the time.

Use of HEPA-filters on buffing machines to prevent dust and pathogens removed from floors from being released into the air.

The buffing machines used under the XRO™ System are all equipped with a HEPA filter to prevent dust and spores removed from floors from being released into the air.

Although this has been suggested and indeed implemented by others and common-sense might dictate its advisability, the Company could not find any studies that gave strong evidence to support that HEPA-filtering of buffing machine were beneficial to patients or health-care workers. However, there is abundant scientific literature to show that the dust created under re-construction in a hospital is laden with pathogens and has been responsible for some reported HAIs. Further, there is abundant literature to show that pathogen spores in dry-form can survive for many months and can be found attached to a variety of surfaces, in particular floors.

Proper care and cleaning of microfiber mops and micro-fiber cloths to maintain quality

Microfiber cloths and mops, *providing* they are used and cared for properly, are far more effective than their cotton counterparts in the removal of dirt (and pathogens) from the environment.

Use of microfiber cloth or mop on a surface with a lot of foreign debris, such as on a floor that has not vacuumed immediately prior to its use, is apt to yield very unsatisfactory results as the microfiber cloth or mop will become quickly saturated with debris. Hence, for floor use, it is important to vacuum prior to use of a microfiber mop. Xanitos believes that microfiber mops, as currently being used in most hospitals, are not realizing the full benefits of microfiber technology as floors are typically not vacuumed prior to mopping.

After use, the microfiber mops/cloths need to be cleaned and sanitized. Commercial laundries are not appropriate for cleaning of microfiber mops/cloths due to excessive heat in this setting during the wash or dry cycles which can cause damage.

Under the XRO™ System and following the microfiber manufacturers' instructions, Xanitos oversees the laundering of microfiber cloths. Washing under high heat is to be avoided as it can damage the fiber. Similarly washing with any cotton, or other lint-producing materials, is to be avoided as the microfiber mops/cloths "pores" can be filled with lint, diminishing their effectiveness. If a washing machine is used for a cotton item prior to washing of the microfiber items, it should be flushed with an empty rinse cycle between cotton and microfiber loads to rid the machine of any cotton fibers.

Warm water flush or pre-wash cycles, 2-3 times, without detergent should be used at the beginning of the wash cycle to release trapped dirt and chemicals from the mops and cloths. A low pH detergent (less than 10.5) should be used when washing microfiber items. Sparse use of detergent (50% less compared with regular cotton cycle) should be used as microfiber has a tendency to retain detergent. A gentle agitation speed should be used to avoid damaging the fibers. Microfiber mops should be washed at a maximum temperature of 140°F. At this temperature bleach (sodium hypochlorite) *must* be added to the wash cycle to ensure that all pathogens are killed. A neutralizer ("souring" agent) must be added during the rinse cycle to remove any bleach residue from the items.

Drying temperature should not exceed 130°F (typically the low or medium dryer setting). Higher temperatures may melt the microfiber and damage the Velcro mop backing. Do not use fabric softener or "dryer sheets" in the dryer. Thoroughly clean the dryer lint trap before drying microfiber items and remove any lint from the dryer drum to prevent lint deposits on the microfiber.

Educating housekeeping staff on its role in the prevention of deaths and illness by HAI and on-going training of housekeeping staff on proper cleaning techniques

Although obvious, no environmental cleaning process is apt to be effective unless the housekeeping staff follows such process scrupulously. To this end, Xanitos invests heavily in recruiting and training high caliber on-site management team and operations management that provides oversight of the onsite management team. Additionally, the Company (i) educates and sensitizes the housekeeping staff of its role in the prevention of death and illness by proper cleaning to reduce HAIs and (ii) provides ongoing training of the housekeeping staff on proper cleaning techniques. Finally, the Company is fully committed to providing a quality product to its clients and firmly believes that by placing quality above short-term profits, long-term profits will follow. It is precisely this emphasis on (i) recruiting high caliber management, (ii) ongoing training at all levels of the organization, and (iii) exceptional execution that has made the founder and CEO of Xanitos, Graeme Crothall, recognized as the leader in the healthcare environmental outsourcing industry in this country and was undoubtedly responsible for the success of his prior companies in this industry (two of which make up the largest companies in this industry).

One of the techniques used with the XRO™ System to train housekeepers on the effectiveness of their cleaning of touch-points is the use of a solution that fluoresces in

the presence of UV light when there are pathogens. The Company has found this to be an excellent tool in training housekeepers. The housekeepers are surprised to find that the surface they thought they had cleaned is still dirty.

The importance of educating and training of the housekeeping staff and on the ensuring adherence to protocols by such staff is illustrated well in a study by a hospital attempting to eradicate VRE. Hota et al¹⁹ reported on a sequential trial in which a multi-faceted environmental cleaning intervention was introduced in a MICU and a respiratory step-down unit. The intervention included educational lectures to the housecleaning staff and observations of their cleaning, without changes in cleaning procedures or cleaning products. As a result of this intervention, a greater percentage of touch-points were cleaned. With every 10% increase in sites cleaned, a 6% decrease in the prevalence of VRE was realized!

IV. Xanitos Anecdotal Evidence Supporting the Effectiveness of the XRO™ System in the Reduction of HAIs

1. Progressive Reduction in Dust Collected by Xanitos from “start-up” by Xanitos to six-months post-start up.

Xanitos has observed that when it first starts cleaning a client-hospital that the vacuum-cleaners collects a tremendous amount of dust per week and that the amount of dust collected per week gradually tapers off, reaching a steady-state after about 6-8 weeks. This data, Xanitos believes, is clear evidence that the hospital is becoming progressively cleaner over the first 6-8 weeks. The decreasing amount of dust collected per week implies that the amount of ambient dust, and hence the number of pathogens, in the environment, is decreasing over this same time period.

At Olean Hospital, in New York, Xanitos found that when it first started cleaning the hospital, it was collecting 4.4 lbs of dust per week from its two vacuums. After about six weeks, the amount of dust collected per week leveled off to approximately 1.0 lb per week. A reasonable extrapolation of this data is that the amount of dust and hence number of pathogens in the air decreased by roughly a factor of 4 over the first six weeks of Xanitos implementing the XRO™ System.

2. Improvement in air quality

Although an indirect measurement, at Children’s Hospital of Wisconsin (CHOW), air quality samples have been taken. It’s been reported by the administration of CHOW that the air quality has improved markedly since Xanitos started cleaning.

3. Reduction in HAIs at a client's hospital after implementation of the XRO™ System and after educating housekeepers on the importance of cleaning of touch-points.

At one of Xanitos' client hospitals (that wishes to remain anonymous), after instituting a program in which the housekeepers were educated on the importance of cleaning of touch-points, a marked drop was seen in certain (monitored) HAIs, as reported below:

- The number of HAI- MRSA cases dropped from 137 in the 2008 to 37 in 2009 through mid-June.
- The number of CLABSI-ICU case dropped from about 5 per month in 2008 to 1 per month in 2009.
- The number of VAP dropped from 9 per month in 2008 down to about 5 per month in 2009.

V. Conclusion and Recommendations

Xanitos believes that environmental cleaning processes, if properly designed and scrupulously adhered to, can play a significant role in the fight against HAIs. It further believes that its XRO™ System offers significant improvement over other conventional cleaning practices as they exist today in US hospitals. The Company also, however, recognizes that as a guest in a client's hospital it needs to conform to the infection control practices of the client hospitals and is willing, accordingly, to modify its environmental cleaning processes to conform to its client's wishes.

The literature appears to strongly support what Xanitos is doing under the XRO™ System. Perhaps the paper that most strongly supports the more novel aspects of the XRO™ System is a paper by A. Zafar et al²⁰ describing the interventions done at Columbia Arlington Hospital to control nosocomial *Clostridium difficile*. In 1991, an aggressive infection control focusing on environmental cleaning was instituted. The incidence of CD dropped from 111 cases per year down to 55 cases per year after the intervention. Environmental efforts included: (i) mops and water changed for each isolation room; (ii) phenolic disinfectant/ mechanical cleaning of toilets, reusable bedpans, furniture, floors (patient room, patient bedroom, & soiled utility room), sinks, bedrails, telephones. Special cleaning attention to area around toilet; (iii) carpeted areas cleaned by deep vacuuming; and (iv) all wheel chairs, iv poles, stretchers, etc., not in direct contact with patient skin, cleaned by housekeepers daily and cart-washed every six (6) months.

The authors of this paper were asked by Xanitos management to not only give a "scientific review of the XRO™ System", but also to give recommendations that Xanitos

management and client hospitals might want to consider to further improve its cleaning processes. Our recommendations are as follows:

1. More emphasis on and more frequent cleaning of “touch-points”, perhaps at the expense of less frequent mopping of the floors. The literature strongly suggests that contaminated “touch-points” are far more of an issue in the dissemination of pathogens than floors (particularly after they’ve been vacuumed). If the floors were only “spot-mopped”, except for terminal cleaning and isolation rooms, the delta time and cost associated with additional touch-point cleaning could be offset by the lower time and cost associated with less frequent floor-mopping.

The payoff in scrupulous cleaning of touch-points is highlighted in the results of a study published by M. Hayden et al²¹. Here, she showed that, “We found that enforcing routine environmental cleaning measures was associated with less surface contamination with VRE, cleaner healthcare worker hands, and a significant reduction in VRE cross-contamination in an MICU with high-level VRE endemicity. These improvements occurred despite ongoing admission of VRE-colonized patients to the MICU and only moderate rates of adherence to proper hand hygiene.”

2. Use of a multi-step cleaning process on surfaces exposed to human secretions/ fluids.

Effective cleaning is truly a multi-step process: (i) removal of any solid or liquid debris, (ii) cleaning of the surface to remove residual foreign material, and (iii) disinfecting the surfaces. Until essentially all the foreign material has been removed, disinfecting the surface is not likely, and indeed there is a likelihood of the cleaning process spreading rather than removing pathogens.

Hence, the recommendation is that (i) if there’s actual human secretion/ fluid on a surface, it first be mopped up with a cloth; (ii) a second cloth, pre-soaked in a Neutral Cleaner, should clean the surface; and (iii) a third cloth, presoaked in Virex, should be used to disinfect the same area. Obviously, if there’s no human secretion/ fluid on a surface, but just the stain of such, the first step can be eliminated.

This multi-step process was shown to be the only effective method in eliminating Norovirus in a study by J. Barker et al. This study compared five different cleaning and disinfection protocols: (a) cleaning with a cloth-soaked in detergent; (b) cleaning with a cloth-soaked in detergent and then rinsing, wringing-out cloth and re-cleaning surface; (c) applying hypochlorite/ detergent to surface for 1 minute and then applying protocol (a); (d) applying hypochlorite/ detergent to surface for 5 minutes and then applying protocol (a); gross fecal-matter removed by initial wipe with cloth soaked in detergent and then the surface is cleaned via method (c).

3. Routine use of fluorescent marking systems in terminal room cleaning for touch-points, particularly those surfaces known to harbor pathogens and known to be neglected, in (a) isolation rooms or (b) rooms where the prior patient that occupied the room was later found to be infected with MRSA, VRE, or other highly contagious pathogens.

Although implementing this program would decrease room turn-around time and increase cost marginally, the literature seems to support that (a) at best, there is a high incidence (>10%) of touch-points not being cleaned by housekeeping even with education, training, and supervision, (b) environmental surfaces which were near the patient are often contaminated with the same pathogens which infected the patient, and (c) there is at least some documented proof of patients being infected by pathogens infecting the room's prior patient.

4. Use of fluorescent markers as part of a quality control program in which there would be a random sampling (computer generated list of places to measure) of daily cleaning of patient rooms. It is envisioned under this program there would be targets set by Xanitos management in terms of percent of touch-points "cleaned" developed by management, that stats would be monitored, reviewed with housekeeping staff, and posted. It might also be worthwhile to give small prizes to the housekeeper if the overall goals were met (e.g., baseball caps, coupons to fast-food chains, etc.).
5. Use of Polymer Technology Disinfectant (in lieu of a conventional disinfectant)

Recently, there have been reports of a new polymer-based disinfectant, Polysphere, made by Byotrol, Inc., that is biocidal for approximately three days after it has dried on an applied surface. The polymer entraps the added quaternary ammonium disinfectant and forms a monolayer on the applied surface. Byotrol works on three levels: (i) it is biocidal on initial contact; (ii) the dry monolayer continues to kill bacterial and viral cells, spores, fungi, and algae; and (iii) it inhibits biofilm formation by interfering with and disruption of microbial attachment. The product reportedly leaves no residual film and is comparable in cost to VirexII.

A summary of the results of reports we found in the literature on its use are as follows:

- In 6-month study at a ward in Glasgow Royal Infirmary, high contact surfaces were treated with Polysphere. A 75% reduction in MRSA was achieved.
- In a test in the microbiology lab Monroe Hospital in Bloomington, IN, a non-porous surface was cleaned with either Polysphere or sterile water and was inoculated with VRE or MRSA. Surface was swabbed daily for 3 days. Polysphere surface grew no VRE, and a negligible amount of MRSA.

- In a 32 bed acute care facility, since use of this product in March 2007, there have been *no* documented cases of hospital-acquired MRSA . Staff has also noticed that no lime, rust or calcium build-ups occur on bathroom fixtures where the product is used.
- At the same facility, a test was conducted to identify the presence of ATP, a molecule common in all micro-organisms. The ATP levels as measured with ultraviolet light in a number of patient rooms prior to using Polysphere were between 122 and 197 RLUs (relative light units). After several weeks of cleaning with Polysphere, the same patient rooms had ATP levels of between 2 and 17 RLUs.

Xanitos is currently working with Byotrol to find answers to various unanswered questions including (i) correct methods of disposal of Polysphere effluent, (ii) its biocidal properties with respect to Hepatitis B and TB, (iii) optimal methods of application for a variety of surfaces (door knobs, electronic controls such as bed-controls, TV remotes, etc., curtains, etc.), and (v) more detail on the relationship between its biocidal properties and the time the surface remains wet.

¹ Huang, S. ,Datta, R., Platt, R., Risk of acquiring antibiotic-resistant bacteria from prior room occupants, Archives of Internal Medicine, 2006, Vol. 166, 1945-1951.

² Kumari, D., Haji T., Keer, V., et al, Ventilation grilles as a potential source of methicillin-resistant Staphylococcus aureus causing an outbreak in an orthopaedic ward a district general hospital. Journal of Hospital Infection, 1998; 39: 127-133.

³ Rampling, A., Wiseman S., Davis, L., et al, Evidence that hospital hygiene is important in the control of methicillin resistant Staphylococcus aureus, Journal of Hospital Infection, 2001; 49: 109-116.

⁴ Hota, B., Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection? Clinical Infectious Disease, 2004; 39:1182-1189.

⁵ Kramer A., Schwebeke I., Kampf G., How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infectious Diseases, 2006, 6:130.

⁶ Wagenvoort, J.H.T., Sluijsmans, W., Penders, R.J.R., Better environmental survival of outbreak vs. sporadic MRSA isolates, Journal of Hospital Infection, 2000, 45: 231-234.

⁷ Dancer, S.J., Mopping up hospital infection, Journal of Hospital Infection, 1999, 43:85-1000.

⁸ Sexton, T., Clarke, P., O'Neill, E., et al., Environmental reservoirs of methicillin-resistant Staphylococcus aureus in isolation rooms: correlation with patient isolates and implications for hospital hygiene.

⁹ Lehman, D., Microfibers, macrobenefits, Healthcare Facilities Management, January 2004, 42:444.

-
- ¹⁰ Easter, E., Microfiber technology used for cleaning in the healthcare industry, presentation to Xanitos management, June 28, 2009, Jackson Hole.
- ¹¹ Exner, M., Vacata, V., Hornei, B., Dietlein, E., Gebel, J., Household cleaning and surface disinfection: new insight and strategies, *Journal of Hospital Infection*, 2004, 56, S70-S75.
- ¹² Ratula, W., Gergen, M., Weber, D., Microbiologic evaluation of microfiber mops for surface disinfection, *American Journal Infection Control*, 2007, Vol. 35, No. 9, 569:573.
- ¹³ Russel, A., Bacterial adaptation and resistance to antiseptics, disinfectants and preservatives is not a new phenomenon, *Jouranal of Hospital Infection*, 2004; 57: 97-104.
- ¹⁴ Dharan, S., Mourouga, P., Copin P. et al, Routine disinfection of patients' environmental surfaces. Myth or reality?, *Journal of Hospital Infection*, 1999, 42: 113-117.
- ¹⁵ Barker, J., Vipond, I., Bloomfield, S., Effects of cleaning and dsinfection in reducing the spread of Norovirus contamination via environmental surfaces, *Journal of Hospital Infection*, 2004; 58, 42-49.
- ¹⁶ Ray, A. Hoyen, C., Das, S. et al, Nosocomial transmission of vancomycin-resistant enterococci from surfaces. *JAMA*, 2002; 287: 1400-1401.
- ¹⁷ Boyce, J., Potter-bynoe, G., Chenevert, C., et al, Environmental contamination due to methicillin-resistant *Staphylococcus- aureus* (MRSA): possible infection control issues. *Infection Control Hopsital Epidemiology*, 1997; 18: 622-627.
- ¹⁸ Bhalla, A., Pultz, N., Gries, D., et al, Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients, *Infection Control and Hospital Epidemiology*, 2004; 25: 164-167.
- ¹⁹ Hota, B., Blom, D., Lyle, R., et al, Interventional evaluation of environmental contamination by vancomycin-resistant enterococci: failure of personnel, product, or procedure?, *Journal of Hospital Infection*, 2009; 71: 123-131.
- ²⁰ Zafar, A., Gaydos, L., Furlong, W. et al, Effectiveness of infection control program in controlling nosocomial *Clostridium difficile*, *American Journal of Infection Control*, 1998; Vol 26, No. 6: 589-593
- ²¹ Hayden, M., Bonten, J., Lyle, E., et al, Reduction in acquisition of vancomycin-resistant enterococcus after enforcement of routine environmental cleaning measures, *Clinical Infectious Diseases*, 2006; 42: 1552-1660.