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Enhanced Environmental Cleaning with Hydrogen Peroxide (H₂O₂) Gas and the Effect on Hospital-Acquired Infection (HAI) Rates and Acquisition of Methicillin Resistant Staph Aureus (MRSA) and Vancomycin Resistant Enterococci (VRE)
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Background: The University of Pittsburgh Medical Center, Presbyterian is an 766-bed tertiary care facility. The Cardiac Thoracic intensive critical care (CTICU) consists of 2 units: CT10 & CT11, each with 10 beds and similar populations. In 7/08, the CIMR™ Infection Control Technology was installed in CT11. This technology is an ozone-free process that continuously disinfects viruses, bacteria, mold, and other fungi by producing 0.02 ppm of hydrogen peroxide (H₂O₂) gas from oxygen and water vapor in the air. This methodology found that within 24 hours, 96.4% to 99.9% microbial reduction was noted of surfaces contaminated with Staphylococcus aureus, E-Coli, Listeriamono cytogenes, Candidaalbicans, Streptococcus, and Pseudomonas and thereafter new microbe reduction was virtually instantaneous. (Kansas State University and Sandia Labs)

Methods: CT11 was selected as our test (T) unit where on average 59% of patients were colonized with at least 1 significant pathogen. CT10 served as the control (C) unit. The unit was installed in the air handler unit (AHU). Positioning the H₂O₂ unit in the AHU as opposed to the air ducts serving the CT11 was done to ensure that all air entering the CT was treated and not mixed with untreated air. HAIs were defined using National Health System Network (NHSN) criteria. MRSA and VRE screening is routine in our hospital and “As” was defined as a positive following a negative screen. A six month period of HAI and MRSA/VRE As were compared pre and post installation and the T unit was compared to the C unit.

Results:

Periods	HAIs	Patient Days	HAI rate	OR (CI)	P value	MRSA As	MRSA A rate	OR (CI)	P value	VRE As	VRE A rate	OR (CI)	P value
CT11 Pre	19	2158	8.8	1.89 (0.81, 4.53)	0.16	4	1.9	1.19 (0.23,6.68)	1.0	20	9.3	2.25 (0.9,5.6)	0.07
CT11 Post	9	1928	4.6			3	1.5			8	4.1		
CT10 Pre	26	1854	14.0	1.35 (0.76, 2.41)	0.38	1	0.5	0.52 (0.02,7.25)	1.0	7	3.8	0.5 (0.2,1.3)	0.16
CT10 Post	20	1924	10.3			2	1.0			15	7.8		
CT11 vs CT10 Pre			HAI rate	0.62 (0.33, 1.17)	0.16	MRSA A rate		3.44 (0.37,80.9)	0.38	VRE A rate		2.4 (1.0,6.4)	0.05
CT11 vs CT10 Post			HAI rate	0.45 (0.19,1.03)	0.06	MRSA A rate		1.5 (0.2,12.8)	1.0	VRE A rate		0.5 (0.2,1.3)	0.21
All rates in #/1,000 pt-days													

Conclusions:

- CT11 HAI rate was reduced by 48% (8.8 vs 4.6) and the VRE A rate reduced by 56 (9.3 vs 4.1) during the post period, MRSA A rate was unchanged (1.5 vs 1.9).
- VRE A rates were significantly lower in the T vs C unit in the post period and the HAI rate trended towards significance. MRSA A was low in both time periods and in both units.
- Ongoing analysis is planned and further investigation of this technology is merited.

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Abstract

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Objective: It was hypothesized that HAIs and MRSA/VRE acquisitions (As) would decrease if H₂O₂ disinfectant was employed. To test this technology in a health care setting, a test unit was selected and the H₂O₂ unit was installed.

Methods: CT11 was selected as our test (T) unit where on average 59% of patients were colonized with at least 1 significant pathogen. CT10 served as the control (C) unit. The unit was installed in the air handler unit (AHU). Positioning the H₂O₂ unit in the AHU as opposed to the air ducts serving the CT11 was done to ensure that all air entering the CT was treated and not mixed with untreated air. HAIs were defined using National Health System Network (NHSN) criteria. MRSA and VRE screening is routine in our hospital and “As” was defined as a positive following a negative screen. A six month period of HAI and MRSA/VRE As were compared pre and post installation and the T unit was compared to the C unit.

Results: See Results Table

Conclusions:

1. CT11 HAI rate was reduced by 48% (8.8 vs 4.6) and the VREA rate reduced by 56% (9.3 vs 4.1) during the post period, MRSA A rate was unchanged (1.5 vs 1.9).
2. VREA rates were significantly lower in the T vs C unit in the post period and the HAI rate trended towards significance. MRSA A was low in both time periods and in both units.
3. Ongoing analysis is planned and further investigation of this technology is merited.

Setting

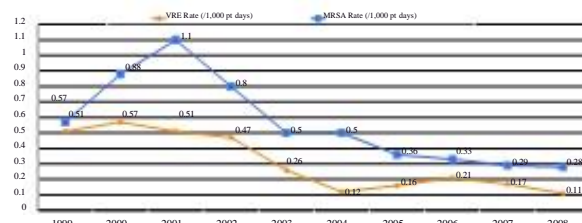
- University of Pittsburgh Medical Center (UPMC)
- Presbyterian Campus (PUH)
- 745-bed tertiary care teaching hospital
- The Cardiac-thoracic intensive critical care (CTICU) consists of 2 units, each with 10 beds and similar populations.

	# Beds	# Patient care areas
ICU	156	9
Non-ICU	589	25



Background

- University of Pittsburgh
- House wide VRE HAI rates 1999 - 2008
- By 2004, the VRE HAI rate was reduced by 70%.
- By 2005, the MRSA HAI rate was reduced by 74%.
 - These low rates have been sustained.
 - However more VRE/MRSA HA C and HAIs occurred in ICU patients than ward patients.





Background H₂O₂ as a Vapor Disinfectant



- Oxidizing agent that degrades to water, O₂ and free hydroxyl radicals
 - Causes destruction of bacterial cell membranes
 - Oxidation of coenzyme A
 - Leakage of K⁺ ions
 - Denatures DNA/RNA causing fatal errors

Background A New Technology for Healthcare Application

- Used in healthcare and pharmaceutical industry for bio-decontamination of rooms, labs or whole patient care areas
- Hazardous to the respiratory tract so OSHA sets allowable limits 1ppm over 8 hour time period
- Currently, two decontamination methods are commercially available:
 - 30% Liquid H₂O₂
 - H₂O₂ Vapor Emission - 0.02 ppm continuous vapor
- Useful technology to be familiar with when a need arises



- use of product names does not indicate endorsement

Background What is Superoxide Technology?

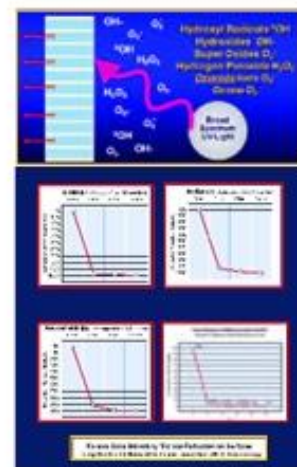
- Ozone free process that continuously disinfects viruses, bacteria, mold, and other fungi by producing 0.02 ppm of hydrogen peroxide (H₂O₂) gas from oxygen and water vapor in the air.
- 96.4% to 99.9% microbial reduction was noted of surfaces within 24 hours
- The process is 'residue-free', breaking down to water vapor and oxygen - hence representing an extremely "green" or **environmentally friendly biocide**.



Environ Sci and Tech 2007;41:606-612

H₂O₂ Continuous Vapor Emission

- This technology combines UV lamp radiation with TiO₂ photooxidation
 - UV lamp lasts for 36 months
 - Produces H₂O₂ /free radicals from humidified air
 - Requires no renewable H₂O₂ source
 - Odorless
 - No OSHA exposure issues
 - Safe to use in occupied areas (patient rooms) ◦ 1 H₂O₂ molecule/10⁶ O₂ molecules
- Reduces free particles in air and chemically inactivates viable pathogens
- University of Kansas/ University of Cincinnati
 - Demonstrated 75-90% inactivation of viral /bacterial bio-aerosols
 - MRSA
 - Bacillus spp.
 - Pseudomonas
 - Mold and viruses
 - Untested against C. diff
- Installation
 - Wall mounted unit for a single room
 - Large unit placed in air handler



Not FDA approved at current time
Environ Sci and Tech 2007;41:606-612

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Objective

- It was hypothesized that HAIs and MRSA/VRE acquisitions (As) would decrease if H₂O₂ disinfectant was employed.
- To test this technology in a healthcare setting, a test unit was selected and the H₂O₂ unit was installed.

Methods

- HAIs were defined using National Health System Network (NHSN) criteria.
- MRSA/VRE acquisition was defined as a positive following a negative screen.
- Study Design - Observational X 1 year.
- Study Unit = CT11
 - On average 59% of patients were colonized with at least 1 significant pathogen.
- Control Unit = CT10
- Study Period = 2 - 6 month periods.
 - Period 1 - 1/08-7/08
 - Period 2 - 1/09-7/09
- In 7/08, the unit was installed in the air handler unit (AH) that serves CT11.
 - Placement in AH as opposed to the air duct was done to ensure that all entering air was treated and not mixed with untreated air.

Outcomes

- All HAIs.
- MRSA/VRE acquisitions.
- Comparisons
 - CT 11 vs. CT10
 - CT 11 pre and post installation.

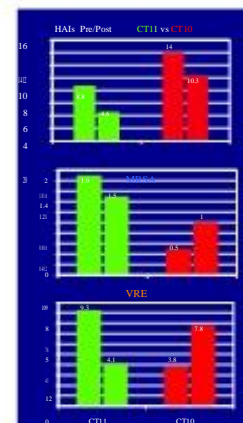


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All rates in #/1,000 pt-days

- CT11 pre/post
 - HAI rate was reduced by 48% (8.8 vs 4.6)
 - MRSA A rate was unchanged (1.5 vs 1.9)
 - VRE A rate reduced by 56% (9.3 vs 4.1)
- CT11 vs CT10
- HAI rates decreased in both units but the reduction was larger in CT11
 - MRSA A was low in both time periods and in both units.
 - VRE A rates
 - More than doubled in CT10
 - Reduced by >50% in CT11



Conclusions

- Superoxide technology appeared to be effective at lowering rates of HAIs and MDRO acquisitions.
- Ongoing analysis is planned and further investigation of this technology is merited.