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Nosocomial Infections and Biozone Air Purifiers

By Lenz Wong

Introduction

Nosocomial infections refer to "hospital acquired" infections arise as complications of the primary reason for being in hospital in the first place (e.g. burn victims acquiring a *pseudomonas sp.* infection). The main features of these infections are:

- **Infectious agents** – the disease causing agents (pathogens) may be part of the normal flora found on perfectly healthy persons and emerge as opportunistic pathogens. Some infectious agents display outright pathogenicity in humans.
- **Sufferers** – these people normally comprise the very young, very old or immuno-compromised where the condition of their body's own defense systems or normal flora allows colonization and proliferation necessary for these infections. Systemic infections may arise and lead to focal infections.
- **Sources and transmission** – The infectious agents are most commonly introduced by people, and occasionally by vectors. Once introduced into the hospital environment these agents are commonly directly or indirectly spread through contact with infected individuals and formites or through the air-borne route. Reservoirs or secondary sources may form where conditions conducive for sustenance or proliferation are available.
- **Environment** – The hospital environment is an indoor environment that houses a community comprising regular healthcare workers and patients. It is also a concentration point of persons requiring healthcare and any associated pathogens

Significance of Nosocomial Infections

An important feature of many nosocomial infections is their resistance to antibiotics. Drug resistance is encoded on specific genes that may traverse between species via plasmids, viruses or other molecular vehicles.

The emergence of multi-drug resistance raises the threat of "super bugs" that are resistant to all currently known antibiotics. Strains of specific organisms have already been isolated that are resistant to antibiotics regarded as the last line of defense in antimicrobial therapies. An extension of the threat of the "super bug" is the chance of escape from hospitals and epidemics that follow.

Pragmatically, these infections raise costs directly in additional medicines or indirectly in resources associated with additional resources such as lengthened hospital stay or course of treatment, and control measures. Depending on a hospital's capacity, this may result in lower productivity, work morale and overall efficiency. Costs for resistance alone are estimated to be in the hundreds of millions of US dollars annually in the USA.

The hospital environment requires special attention focused at controlling the spread of disease between individuals through adequate cleaning and maintenance programs. Besides controlling the administration of antibiotic drugs, adopting strategies to reduce the number of microorganisms at different areas involved in its transmission without the use of antibiotics may have positive short and long-term effect against nosocomial infections.

Reducing Microbial Counts in Indoor Environments

One new method of reducing total microbial counts in indoor environments is the use of gas plasmas, also known as energized gas. Although gas plasmas include ozone as one of its components and by itself is known to possess antimicrobial properties, they include a wider range of antimicrobial reactive oxygen species referred to as reactive oxygen species (ROS) translating to higher potency per ozone output when compared to ozone-only systems.

This gas plasma technology is utilized by Biozone air purification units. These units are used in many different industries such as the food and beverage, indoor air quality and healthcare industries to reduce microbial counts since gas plasmas offer several outstanding features:

- Active antimicrobial effect
- Does not use chemicals, avoiding problems arising from chemical accumulation
- Reduces air-borne microbial counts as well as on surfaces
- Anti-microbial effect reaches spaces that gas plasmas can penetrate

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- Provides microbial count reductions 24 hrs a day and to improve many aspects of indoor air quality
- May be configured for regular decontamination cycles
- May be used in crisis management / bioremediation scenarios
- Low maintenance
- Compliments existing cleaning and maintenance programs

Biozone air purification units have been tested by numerous agencies including FDA and USDA accredited laboratories. The results of these tests have several important indications regarding their application of these units in hospitals and other healthcare facilities.

Significance of Test Organisms used in the Context of Hospitals

In tests conducted by Biozone Scientific, Inc., five different species of bacteria, each of separate genera were used as test organisms (See Biozone Test Reference List at last page). These organisms are identified as nosocomial pathogens. The table below summarizes the significance of these organisms in the hospital context.

Organism Name	Nosocomial Background
Enterobacter aerogenes	Significant hospital pathogen (nosocomial) (1) Infectious diseases caused by *E.aerogenes* (2) include: • nosocomial respiratory tract infections (third leading cause) (3) • wound infections • bacteremia Multidrug resistance on the rise (4) References: 1. Sanders and Sanders. Clin. Microbiol Rev., 1997, 10: 220-241 2. Population and Public Health Branch (Canada) – MSDS for *E.aerogenes*. 3. Chollet, R., et al. Antimicrobial agents and Chemotherapy, April 2002, pp 1093-1097. 4. Van Belkum, et al. CDC Research, Sep-Oct 2001, Vol. 7, No. 5
Escherichia coli	Significant hospital pathogen (nosocomial) (1) Infectious diseases caused by *E. coli* (2) include: • urinary tract infection (leading cause) • travelers' diarrhea • neonatal meningitis • wound infections • peritonitis (inflammation of abdominal wall) • nosocomial pneumonia (up to 50% of all cases) • bacteremia Multidrug resistant strains on the rise (3,4) Some strains produce toxins such as Shiga toxins (5), enterotoxins (6), verotoxins (7). References: 1. Poster# P1398 - Selected poster presentation from the 12th European Congress of Clinical Microbiology and Infectious Diseases, April 2002, Italy, Milan. 2. Population and Public Health Branch (Canada) – MSDS for *E.coli*. 3. Kaye, K.S., et al., Antimicrobial Agents and Chemotherapy, April 2000, pp 1004-1009, Vol 44, No.4. 4. Lautenbach, E., et al. Internal Medicine, Nov 2002, Vol. 162, No.21. 5. Population and Public Health Branch (Canada) – MSDS for *E.coli*, Entoerhemorrhagic 6. Population and Public Health Branch (Canada) – MSDS for *E.coli*, Enterotoxigenic 7. Commun Dis Rep, CDR Weekly, May 1997, 7(19): 165.
Listeria monocytogenes	Selected hospital pathogen (nosocomial) (1) Infectious diseases caused by *L.monocytogenes* (1,2) include: • meningoencephalitis • septicemia • endocarditis Common hospital areas associated with infection include nurseries (1) Multidrug resistant strains exist (3) References: 1. Population and Public Health Branch (Canada) – MSDS for *L.monocytogenes*. 2. Manitoba Health CDC Unit – Communicable Disease Management Protocol, Listeriosis (Nov 2001) 3. Safdar, A. and Armstrong, D. Journal of Clinical Microbiology, Jan 2003, Vol. 41, No.1, p 483-485.

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Organism Name	Nosocomial Background
Salmonella sp.	Hospital pathogen (nosocomial) (1) Infectious diseases caused by *Salmonella spp.* (1) include: • Salmonellosis (acute gastroenteritis and acute infectious disease, headache, abdominal pain, diarrhea, vomiting, nausea) • septicemia • endocarditis • pneumonia • meningitis • osteomyelitis • other focal infections • Reiter's syndrome Multidrug resistant strains prevalent and on the rise (1, 2, 3) References: 1. Population and Public Health Branch (Canada) – MSDS for *Salmonella spp.*. 2. Olsen, S.J., et al - New England Journal of Medicine, May 2001, Vol.344, No.21, p.1572-1579 3. Rissing, J.P. et al –The Certified Medical Representatives Institute, Inc. Continuing Education Article DR-3.
Serratia marcescens	Hospital pathogen (nosocomial) (1) Infectious diseases caused by *S.marcescens* (1,2) include: • meningoencephalitis • osteomyelitis • septic arthritis • otitis media • bacteremia • endocarditis • urinary tract infections • lower respiratory infections • surgical wound • cutaneous infections Common hospital areas associated with infection include nurseries, ICUs and renal dialysis units (1) Multi-drug resistant strains common and on the rise (1,3) References: 1. Population and Public Health Branch (Canada) – MSDS for *S.marcescens*. 2. Johns Hopkins Microbiology Newsletter Vol 16, No.28 3. Champion, H.M., et al. Journal of Antimicrobial Therapy (1988), Vol 22, 587-596

The viable count reduction tests performed on surfaces involving the microorganisms above is summarized in the following table:

Organism Name	Control (CFUs)	Biozone (CFUs)	% Reduction
Enterobacter aerogenes (surface)	>120,000	3900	>96.8%
Escherichia coli	100, 3x10e7	0, 7x10e3	99.9%, 99.9%
Listeria monocytogenes	100, 5x10e7	0, 2x10e4	99.9%, 99.9%
Salmonella sp.	100	0	99.9%
Serratia marcescens	(n/a)	(n/a)	98.4%

Discussion and Summary

Nosocomial infections pose a threat to all people in the widest perspective due to related issues such as resistance. Awareness of the modes of transmission between patients and healthcare workers should be addressed appropriately.

Biozone air purifiers utilize photoplasma which has been lab and field proved for effectiveness in reducing indoor biological contaminants in the form of total microbial counts and specific bacteria. All of these bacteria are known nosocomial pathogens.

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The effectiveness testing of gas plasma technology demonstrates the ability to reduce the number of pathogens in the high nineties percentile both in the air and on surfaces. This indicates the effective use of these gas plasmas in risk reduction strategies against pathogenic and opportunistic organisms, especially for the majority that rely on contact for their transmission.

Of particular significance is *L.monocytogenes* since this is the only Gram positive organism in the panel, bearing notable cell wall resemblance to the most prevalent nosocomial pathogen, *Staphylococcus aureus* and its associated drug-resistant strains such as MRSA and VRSA.

New gas-plasma technologies used in Biozone air purifiers offer many benefits and good potential to users who are interested for the main purposes of improving and maintaining microbial cleanliness and indoor air quality.

These benefits may be realized by a quick retrofit or as plug-and-play modules, complementing any cleaning regime or infrastructure already in place (e.g. HEPA filtration systems, cleaning programs). Hospitals, their staff and patients are good candidates to benefit from these capabilities. □

Biozone Test Report References:

1. For organism *E.aerogenes* : Vallid Labs, Inc. Test ID: Test 5 (27 March 2000)
2. For organism *E.coli* : Tri-Tech Analytical Labs, Inc. Test ID: 02-061078A (29 June 2002),
   : Tri-Tech Analytical Labs, Inc. Test ID: (not available).
3. For organism *L.monocytogenes* : Tri-Tech Analytical Labs, Inc. Test ID: (not available).
4. For organism *S.marcescens* : Academy of Military Medical Sciences, IME, China. Test ID: 29 May 03
5. For organism *Salmonella sp.* : Tri-Tech Analytical Labs, Inc. Test ID: 02-061078A (29 June 2002)