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## Compared Antibacterial Effects of Nanosilver and Deconex on Multidrug Resistance Microorganism

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The aim of this study was the evaluation susceptibility of multidrug resistance microorganism to Nanosilver by comparing it with Deconex 5% disinfectant substances. Nanosilver is nanoparticle of silver that is recently being used as antibacterial substance in medicine. This is a cross-sectional study that involved 210 multi drugs resistance microorganism and two type of standard references bacterial as *Escherichia coli* (ATCC-35218 and *S. aureus* (ATCC 25923) assayed for Nanosilver and Deconex 5% antibacterial susceptibility. Antibiotic susceptibility test was done in laboratory of Baqiyatallah Hospital in capital city of Iran. Nanosilver colloid solution brand commercial name 2000sl nanosilver manufactured in Pars Nonacid Company and Deconex 5% (Sterillium) manufacture in Bode-Germany was used. Here 100 g negative and 110 g positive microorganism samples were evaluated. The most common microorganisms were staphylococci, acinetobacter and the most common site of infection was bronchial from ICU admission patients. *Staphylococci aureus* (ATCC 25923), *Escherichia coli* (ATCC-35218) and some hospital microorganism were evaluated to susceptibility of Nanosilver, Deconex 5% and antibacterial drugs. This study showed Nanosilver and Deconex can eradicate more than 96 and 100% of multi drug resistance microorganisms, respectively therefore, more evaluation was needed about consumption of Nanosilver for hand washing and hospital environment disinfectant.

**Key words:** Nanosilver, deconex, antibiotic, multidrug resistance, microorganism

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## INTRODUCTION

Nanosilver is a nanoparticle of silver with the size of 10-100 nm that has different antibiotic, chemical and physiologic effect than usual silver and for this reason, recently, it is used more as an antibacterial substance in medicine (Lok *et al.*, 2006). Nanosilver is new nanotechnology products in medicine (Chan, 2006) and the toxicity of nanosilver in human beings is very rare except in chronic users (Mohan *et al.*, 2010). Nanosilver has small size (less than 2 nm) that increases its various properties such as antibacterial effects and it is disturbed in small size therefore, it can be used as disinfectant substance for hospital environment (Chen and Schluesener, 2008). It is also consumed as antibacterial substance for the care of wounds infection and antibacterial coated device in orthopedic surgery (Adams *et al.*, 1999).

The mechanism of Nanosilver effects are suggested by its binding to cell wall protein and its effects on stages of phagocytosis, translocation, production and regeneration of oxygen, activation of inflammation and cytotoxic cascade that ultimately can cause cell killing (Alt *et al.*, 2004). Nanosilver had more antibacterial effect than silver because nanosilver produced high concentration of silver ions in cell and infectious agent can easily eradicated (Sotiriou and Pratsinis, 2010).

Infection especially hospital acquired is critical disease for human and more generation antibiotic was used for its therapy but in recently, multidrug resistance microorganism was prevalent and it is a life threatening and consumed more budget of health in any countries and therefore use of devices impregnate with antibiotic and silver is one of the new issue for prevention of infection (Murthy *et al.*, 2008).

One of other properties of nanosilver is used for antithrombotic agent and it may be replaced of anti platelet drugs with less complication such as intracranial hemorrhage (Shrivastava *et al.*, 2011). Other properties of nanosilver is cell regeneration and it can use for chronic osteomyelitis as antibacterial and also for improving of bone destruction (Zheng *et al.*, 2010). Anti-inflammatory effect is also other properties of nanosilver while help to repair of wound and burns by nanosilver dressing (Chaloupka *et al.*, 2010). Nanosilver had cytotoxic effect and it can prevent production of vary interferon and interleukins to suppressed immunologic activation of rheumatologic diseases and it can used for remedy of immunologic and inflammatory disease (Shin *et al.*, 2007). Nanosilver was used widely in world and add to use in

medicine it extensively used in food packaging , waste water, domestic consume products and cloths therefore its toxicity should be consider and more study yet was need (Faunce and Watal, 2010).

Because Nanosilver was recently recommended as a disinfectant substance and generally any disinfectants are safe for human use and one can be certain of microbial eradication, it is for this reason that we decided to evaluate bacterial resistance and susceptibility of Nanosilver.

## MATERIALS AND METHODS

This is a cross-sectional study that involved 210 multi drugs resistance microorganism cultures with 100 out of them gram-negative and remaining others were gram-positive organisms which were assayed for Nanosilver and Deconex 5% antibacterial effect. These tests were done in the clinical laboratory of Baqiyatallah Hospital depend to Baqiyatallah University of Medical Sciences in Tehran capital city of Islamic Republic of Iran in 2009-2010. Two types of standard reference bacterial as *Escherichia coli* (ATCC-35218) and *S. aureus* (ATCC 25923) were also evaluated. Nanosilver colloidal solution with brand commercial name of 2000 sl nanosilver manufactured by Pars Nonacid Company of Iran was used. Each milliliter of this solution has 8 ppm Nanosilver. Deconex 5% (Sterillium) is a Propanol-based alcohol hand disinfectant manufactured in Bode, Germany. According to standard test NCCLS-M7, 500000 mL of bacteria was diluted to 1/100 in 0.5 McFarland tube and cultured in Muller Hinton media. Nanosilver was micro diluted to ten tube as 0.005, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08 and 0.09. Microorganism cultures were incubated in 35°C aerobic for 48 h. All cultures of microorganism were also assayed for Deconex 5%. The data was then analyzed and used of frequency test with SPSS computer program.

## RESULTS

Total 210 samples with 100 g negative and 110 g positive bacteria were evaluated for effectiveness of Nanosilver and Deconex 5%. Gram-negative microorganism were resistant to Amikacine, Gentamicin, Pencillin, Ampicillin, Cephalexin, Cefazolin, Ceftriaxon, Cefotaxim, Cotrimaxsol, Amoxicillin, Ciprofloxacin and the gram-positive microorganisms were also resistant to Penicillin, Ampicillin, Eryromycin, Clindamycin, Cephalexin, Cefazolin, Ceftriaxon, Nafacillin, Cloxacillin and Gentamicin. Except *Staphylococci aureus*, the most common microorganism was *Acinetobacter* as gram

Table 1: Prevalence of organism and site of infection

Sample	Nasotracheal				Total
	Wound	tube	Urine	Blood	
Acinetobacter	8	32	1	2	52
<i>Pseudomonas aeruginosa</i>	13	15	1	1	32
<i>Kelebsiella pneumoniae</i>	8	0	0	4	16
<i>Staphylococci aroise</i>	53	48	0	1	110
Total	82	95	2	8	210

Table 2: Microorganism detection in Hospital wards

Wards	Microorganism				Total
	Acenitobacter	<i>Pseudomonas</i>	<i>Kelebsiella</i>	<i>Staphylococci</i>	
ICU	38	20	6	59	123
General	8	5	7	21	41
Surgery	2	1	0	20	23
Emergency room	4	1	3	5	13
CCU	0	1	0	5	6
Transplant	0	4	0	0	4
Total	52	32	16	110	210

Table 3: Susceptible microorganism to Nanosilver

Microorganism	Sensitive (<0.02 ppm)	Intermediate (0.2-0.03 ppm)	Resistance (>0.03 ppm)
Acinetobacter	29	22	1
<i>Pseudomonas</i>	18	10	4
<i>Kelebsiella</i>	16	0	0
<i>Staphylococci</i>	90	17	3
Total	153	49	8

negative that is showed in Table 1. Bronchial sample in ICU admitted patients is the most common site for the detection of microorganism that is shown in Table 2 and 3.

The minimum concentration prevention growth of Nanosilver for the standard *S. aurous* (ATCC 25923) and *Escherichia coli* (ATCC-35218) were 0.02 and 0.03 ppm, respectively.

No any microorganisms such as gram positive and gram negative grow in culture media contain Deconex 5%.

## DISCUSSION

This study showed that 100 and 96% of multi-drug resistance gram positive and negative microorganism cannot grow in media environment to deconex 5% and Nanosilver, respectively.

Nosocomial infection is an important health problem and sepsis syndrome and septic shock may be induced by infected devices, environment and contaminated hands of health care workers. Therefore, suitable disinfectant was needed (Ghorbani, 2009). Nanosilver is recently, used as an antibacterial substance in medicine and in health care units (Edwards-Jones, 2009).

Nanosilver is implicated as antibacterial substance in devices of surgery such as orthopedics (Alt *et al.*, 2004) and gynecology for anti pregnancy intrauterine devices (Paulo *et al.*, 2010). Nanosilver is also used as disinfectant substance in hospitals and helps to reduce nosocomial infections. However, as every hospital has different antibiotic uses and may have different antibacterial resistance microorganisms therefore, different antibiotic and disinfected substances may be needed (Silvestry-Rodriguez *et al.*, 2007). Hand washing is an important prevention strategy for nosocomial infection in the world and different disinfectant was used for hand hygiene (Jia *et al.*, 2008). On the other hand, safety and case benefit disinfectants without any adverse effects prefer for use in staff of hospital. Each disinfectant could be used as an eradicating substance for bacterial and viral pathogen from hospital environment and instrument and hands. We examined the microorganism growths in culture media for Nanosilver and compared with Deconex 5% disinfection solution and found that Deconex had a good prevention growth effect and all the multidrug resistance microorganisms were stopped their growth. Thus hospital pathogens and standard *Staphylococci* and *E. coli* organisms could not grow in specific media that contain Deconex that it comprises of alcohol is the reason that has a good antibacterial effect (Buergers *et al.*, 2008). Nanosilver effects are different in diverse concentration and minimum Concentration for prevention growth of *Staphylococci* was 0.02 ppm and for *E. coli* 0.03 ppm.

Acinetobacter is an important cause of nosocomial infection that often has multidrug resistance properties. Acinetobacter causes severe infection in ICU by contaminated instrument and environment and also causes prolonged occupation beds of ICU wards. Acinetobacter has only less than 2% resistance to 0.03 ppm of nanosilver therefore we think that higher concentration of Nanosilver should be evaluated for this microorganism (Dryden, 2010).

*Kellebsiella* is another multidrug resistance hospital pathogen that causes most nosocomial pneumonia and urinary tract infection worldwide and it can produce betalactamase enzyme and is therefore, resistant to betalactam antibiotics and some time can cause out break in hospital. Its growth prevented about 100% by nanosilver thus it can use as a good disinfectant substance (Batchoun *et al.*, 2009).

*Pseudomonas aeruginosa* also is one of the most common causes of resistant nosocomial infection that it transmitted to patient by the way of invasive and non

invasive instruments and from hospital environment that in here showed that nanosilver stopped 97% of *Pseudomonas* growth so it can be used as disinfectant substance (Longtin *et al.*, 2010).

*Staphylococcus aureus* is the most common cause of nosocomial infection that it already transmitted to patients by the contaminated hands of healthcare workers and the environment of hospital and more than 97% of this strain was sensitive to nanosilver and so higher concentration of Nanosilver should be examined for *Staphylococcus aureus*. Hand hygiene is a primary tool for the reduction of hospital infections therefore, hand hygiene agents should be less irritating to skin. On the other hand, previous disinfectants had some adverse effects and cause less compliance of health care workers for hand washing therefore nanosilver should be evaluated for use as a hand washing agent (Kampf *et al.*, 2005). In this study, the most common source of infection was tracheal in patients with nasotracheal tube residence in ICU and wounds as diabetic foot or pressure sores that the most common organism isolated from them was acinetobacter and *staphylococcus aureus*, respectively (Babu *et al.*, 2006). Nosocomial infection is important and causes occupation of beds and high morbidity and mortality, therefore disinfectant substances is very important for the prevention of infection in ICU ward and Nanosilver can be replaced if more studies will confirm it (Mader *et al.*, 2010). In this study, the most common pathogens were found susceptible to Deconex as disinfectant solution and it used as routine disinfectant substances in Iran. However, it has more irritant and breath stimulating effects that reduce compliance of healthcare workers for hand washing. Therefore, a better disinfectant with less adverse effect is needed (Burgers *et al.*, 2008).

Overall more than 96% of multidrug resistance hospital organisms can be eradicated by 0.03 ppm of Nanosilver and therefore more concentration of Nanosilver should be evaluated as disinfectant (Madhumathi *et al.*, 2010).

### CONCLUSION

This study demonstrated that Nanosilver and Deconex can eradicate more than 96 and 100% of multi drug resistance microorganisms, respectively. Therefore, we recommend that more studies should be carried out for the uses of Nanosilver for hand washing and as hospital environment disinfectant. This study showed multi drug resistance microorganisms. Therefore, more evaluation

was needed about consumption of Nanosilver for hand washing and hospital environment disinfectant.

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