MICROBIOLOGY

THE EFFECTS OF GOLD NANOPARTICLES AGAINST METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* (MRSA) ISOLATED FROM CLINICAL SAMPLES IN QASSIM REGION, SAUDI ARABIA

Mariam Almutairy[1], Ahmad Almatroudi[1], Ayman Albehity[2], Khaled Allemailem[1,3]
[1]Department of Medical Laboratories, College of Applied Medical Sciences, Qassim University, Saudi Arabia
[2]Department of Public Health, College of Public Health and Health Informatics, Qassim University, Saudi Arabia
[3]Department of Basic Health Sciences, College of Applied Medical Sciences, Qassim University, Saudi Arabia

Background

- In recent decades, pathogenic bacteria started to develop resistance to extensively used antibiotics, called Multi-drug resistant (MDR) bacteria **(1).**
- One of the major pathogens is MRSA, which can develop antimicrobial resistance (AMR). It is responsible for the most hospital- and community-acquired infections **(2).**
- Traditional antimicrobials are being replaced by more effective and new antibiotics to reduce the frequency of MDR bacteria against antibacterial therapy.
- Nanotechnology has been proven to be very promising and provides a great hope in overcoming MDR bacteria **(3).**
- This study aimed to investigate the antibacterial effect of Gold nanoparticles (AuNPs) against Methicillin Resistant *Staphylococcus aureus* (MRSA) strains.

Methods

- The study included 28 samples MRSA strains. The samples were randomly collected and isolated from nasal swabs of hospitalized patients in different hospitals among Qassim region, Saudi Arabia during the period between September and November 2019. Additionally, 2 ATCC strains were also used as a reference strain. MRSA were isolated and identified using conventional methods. They were then confirmed using BeckmanCoulter MicroScan WalkAway plus System.
- The minimum inhibitory concentrations (MICs) for were determined using broth macrodilution method which was indicative of the right line for examination of antimicrobial agents in Deutsche Medizinsche Gesellschaft (DMG). Serial dilutions of AuNPs were made in a nutrient broth medium which was inoculated with a standardized number of MRSA and incubated for a 24 h. The turbidity of the actively growing broth culture is adjusted (Sensititre Nephelometer) with sterile saline to obtain turbidity optically comparable to that of the 0.5 McFarland standards (ca 1 × 10^8 KbE/ml). The lowest concentration (highest dilution) of AuNPs preventing appearance of turbidity was considered to be the MIC.
- To determine the minimum bacterial concentration (MBC), 50 µl aliquot of tubes that did not illustrate turbidity was transferred in Tryptose Soya Agar (TSA) plates which were not supplemented with AuNPs and then incubated at 37° C for 24 hr. All plates were examined before and after incubation for presence or absence of bacterial growth. Plates which displayed no growth of bacteria indicated that the concentration of NP was lethal. The number of surviving organisms were determined by viability counts. The lowest concentration of NP that inhibited the growth of ≥99.99% of MRSA was defined as MBC. All experiments were duplicated on two different days.

Results

- A total of 28 MRSA strains were successfully isolated. Furthermore, 2 ATCC strains were also used in study as reference strain.
- The study found that all MRSA tested strains were sensitive to AuNPs at different concentrations, starting from 100 µg/ml up to 3.12 µg/ml (Table 1).
- Both ATCC strains showed the same results which were sensitive at 50 ug/ml MIC dilution. Table 1 shows ATCC strains as strain number 1 & 2.

Table 1; MICs of AuNPs against MRSA strains; Light pink color = Turbidity indicating growth. Purple color = No turbidity indicating absence of growth.

Strain	Concentrations (µg/ml) of AuNPs									
	200	100	50	25	12.5	6.25	3.12	1.56	0.78	0.39
1 ATCC			MIC							
2 ATCC			MIC							
3				MIC						
4			MIC							
5				MIC						
6			MIC							
7			MIC							
8			MIC							
9					MIC					
10					MIC					
11						MIC				
12			MIC							
13			MIC							
14			MIC							
15			MIC							
16			MIC							
17			MIC							
18			MIC							
19			MIC							
20							MIC			
21				MIC						
22				MIC						
23				MIC						
24		MIC								
25			MIC							
26			MIC							
27		MIC								
28		MIC								
29			MIC							
30				MIC						

- All MRSA strains were sensitive to AuNPs at different concentrations. The majority of MRSA (17/30), 56.7% of total, were sensitive at 50 µg/ml, followed by 6 strains (20%) were susceptible at 25 µg/ml. Other 3 samples (10%) were sensitive at 100 µg/ml of AuNPs. The concentration of 12.5 µg/ml affected 2 MRSA (6.7%). Only 1 MRSA (3.12%) was susceptible to MIC at 6.25 µg/ml of AuNPs, and another one was also susceptible to MIC on 3.12 ug/ml dilution as indicated in figures 1 and 2.

Results

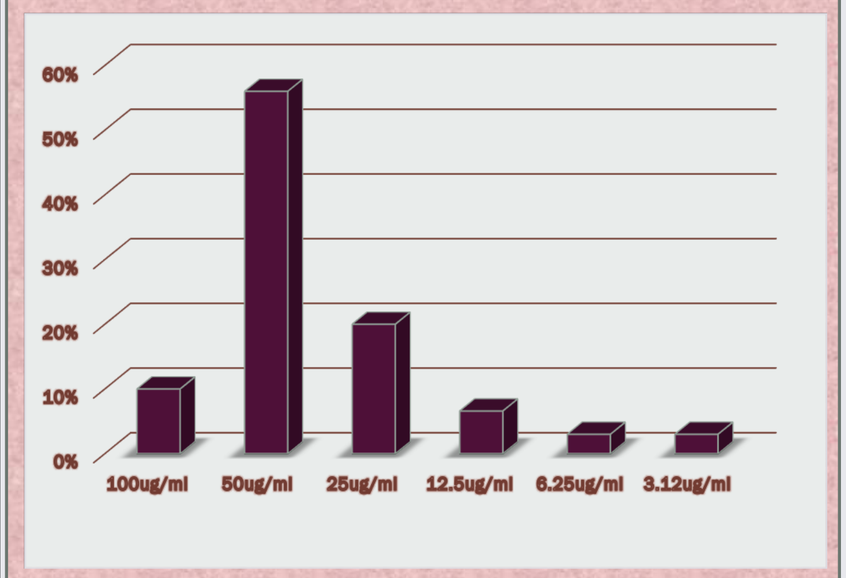

Figure 1; The percentage of affected MRSA at different MIC dilutions of AuNPs; shows that majority of strains were sensitive at 50 ug/ml MIC dilution. The concentration was as ug/ml.

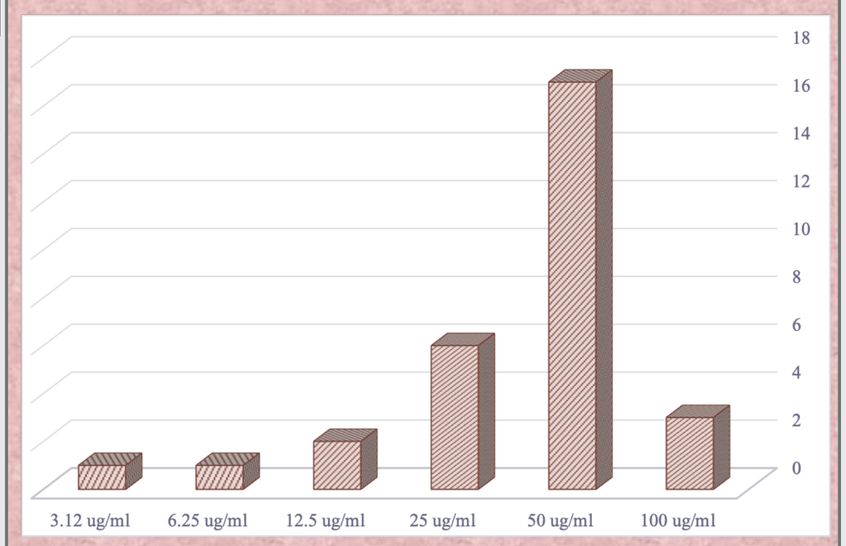

Figure 2; The number sensitive MRSA to AuNPs at different MIC; shows that majority of strains were sensitive at 50 ug/ml MIC dilution. The concentration was as ug/ml.

Conclusion

- A very recent study found that all *S. aureus* strains isolated from clinical and subclinical were susceptible to AuNPs at different concentrations including 200, 100 and 50 µg/ml **(4).**
- The study indicated that all MRSA strains were found to be susceptible to AuNPs at different concentrations showing the potential antibacterial activity of AuNPs.
- Further studies are required to investigate the antibacterial effect of AuNPs against different types of bacteria. Using different NPs is also required.

References

1. Harkins, C.P., *et. al.* (2017). Methicillin-resistant *Staphylococcus aureus* emerged long before the introduction of methicillin into clinical practice. *Genome Biol.*, 18(1), p.130.
2. Tenover, F.C., McDougal, L.K., Goering, R.V., Killgore, G., Projan, S.J., Patel, J.B. and Dunman, P.M. (2006). Characterization of a strain of community-associated methicillinresistant *Staphylococcus aureus* widely disseminated in the United States. J CLIN MICROBIOL, 44(1), pp.108–18.
3. Niemeyer, C.M. (2001). Nanoparticles, Proteins, and Nucleic Acids: Biotechnology Meets Materials Science. *Angew. Chem. Int. Ed. Engl.*, 40(22), pp.4128–4158.
4. Elbehiry, A. *et. al.* (2018). Antibacterial effects and resistance induction of silver and gold nanoparticles against *Staphylococcus aureus* -induced mastitis and the potential toxicity in rats. *Microbiologyopen*, 8(4), p.e00698.

Contact details

Mariam Almutairy: mariam_050789_xx@outlook.com
Khaled Allemailem: k.allemailem@qu.edu.sa
Ayman Elbehiry: ar.elbehiry@qu.edu.sa
Ahmad Almatroudi: aamtrody@qu.edu.sa