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SUPERBUG INFECTION

Reshma Rajendran*

India.

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***Corresponding Author**
Reshma Rajendran
India.

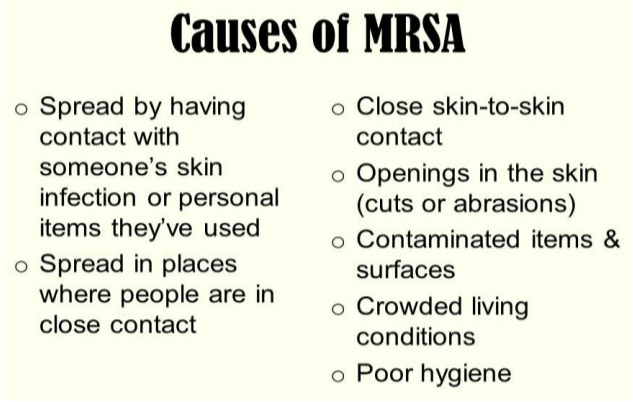
ABSTRACT

Antibiotic resistance has led to the development of so-called "superbugs" that no longer respond to the current treatment modalities. The antibiotics available to treat these infections are dwindling with very few antibiotics in the pipeline. Infectious diseases are one of the major causes of mortality in children in developing and underdeveloped countries. Limited knowledge of targets (cell wall synthesis, replication, transcription, protein synthesis) for antibiotics and lack of novel antibiotics have lead to an emergence of different level of resistance in bacterial pathogens. Multidrug resistance is the phenomenon by which the bacteria exert resistance against the two or more structurally unrelated drugs/antibiotics. In this review, the key mechanisms of resistance in bacterial superbugs have been discussed as well as that how we can overcome them.

KEYWORDS: Superbug, Bacteria, Resistance, Antibiotics, MRSA.

INTRODUCTION

Superbugs: Drug-resistant microbes, i.e. superbugs, is one of the most dangerous threats in the history of medicine. Superbugs are strains of bacteria that have adapted after coming into contact with an antibiotic. Once this happens, these bacteria become "resistant" the to antibiotic to which they have been exposed, which means the antibiotic cannot kill the bacteria or stop them from multiplying. The term superbug is a nonspecific word that is used to describe any microorganism that is resistant to at least one or more commonly used antibiotics microorganisms resistant to two or more antibiotics.



- Rational use of antibiotics.
- Overuse of antimicrobial drugs
- Inadequate treatment with antimicrobial agent
- Poor drug quality
- Rarely, erratic absorption of drug
- Treatment with wrong kind of infection, in the wrong dosage and for the wrong period of time.
- Non standardize treatment regimen.
- Genetic mutation among the microorganism.

SYMPTOMS

It is normal for healthy people to have staph on their skin. Most of the time, it does not cause an infection or any symptoms. A sign of a staph skin infection is a red, swollen, and painful area on the skin. These staph infections may be in the bloodstream, heart, lungs, or other organs, urine, or in the area of a recent surgery. The signs and symptoms will vary by the type and stage of the infection .A sign of a staph skin infection is a red, swollen, and painful area on the skin. MRSA infections in patients in health care facilities tend to be severe. These staph infections may be in the bloodstream, heart, lungs, or other organs, urine, or in the area of a recent surgery. Some symptoms of these severe infections are:

- Chest pain, Cough or shortness of breath, Fatigue, General ill feeling, Headache, Rash which are mainly seen in the MRSA infection.

TRANSMISSION OF MRSA INFECTION

MRSA infection is mainly transmitted by the physical skin contact by patients. Earlier, MRSA infection was mainly seen in hospital acquired patients but now MRSA infection are

seen in community also. The main factor which affects the transmission of MRSA is the broken or injured skin. When the Patients is hospitalized and visitors are come in contact with patients by kissing, hugging and touching, the visitor gets increases the risk of MRSA infections. Methicillin resistant Staphylococcus aureus progresses substantially inside 24-48 hours of first topical symptoms. Later on 72 hrs, MRSA can take hold in human tissues and eventually become resistant to handling. Usually first symptom of these bacteria is small red bumps that resemble pimples, spider bites or boils that may be followed by fever and from time to time rashes. Within a couple of days the bumps get larger, more painful and finally open into deep, pusfilled boils. MRSA is now resistant to methicillin, amoxicillin, penicillin, oxacillin, and other antibiotics.

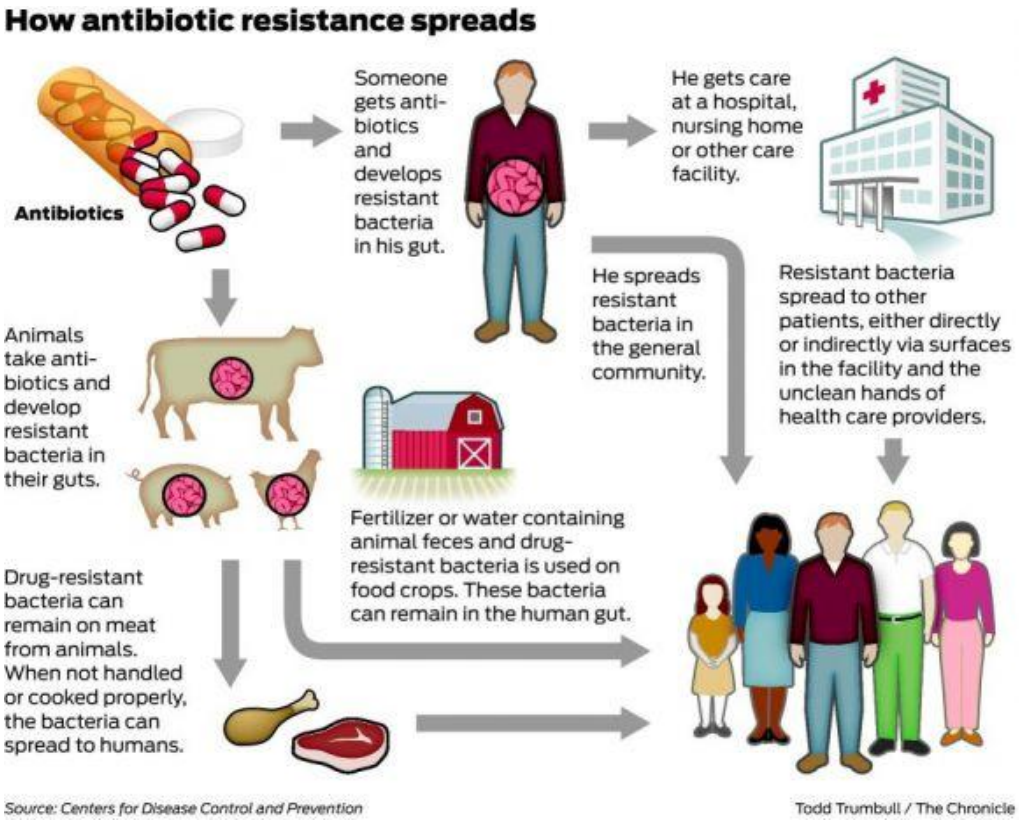


Fig: 1 How Antibiotic Resistance Spreads.

DIAGNOSIS AND TESTING OF MRSA INFECTION

MRSA is mainly diagnosed by mainly skin and soft tissue infection (SSTI) comparable with S. aureus infection.

- A skin sample,
- Sample of pus from a wound,
- Blood, urine, or

Biopsy material is sent to a microbiology lab and cultured for S.aureus. There are mainly 4 types of culturing is mainly done for the diagnosis of MRSA.

Cefoxitin Disk Screen Test

A plate containing 6 µg/ml of oxacillin in Mueller Hinton agar supplemented with NaCl (4% w/v; 0.68 mol/L) as alternative methods of testing for MRSA.[9]

MEDICATION FOR MRSA

Types of antibiotic medications that may work include:

- Clindamycin.
- Damptomycin.
- Linezolid.
- Minocycling.
- Keflex, Bactrim, medicine is used, as new medications for MRSA and should be in regular consultation with your doctor to make sure your boil infection resolves and does not become worse over hours or days.

PREVENTION

- The best way to prevent the spread of S. aureus is for everyone to keep their hands clean.
- It is important to wash your hands properly.
- Health care workers and other hospital staff can prevent staph. Visitors also need to take steps to prevent spreading germs.
- Wash your hands before and after visiting someone in a care home (many hospitals provide an antibacterial gel in wards).
- If you are going into hospital for an operation, ask to be screened for MRSA.
- Put all disposable items, such as dressings, into the appropriate bins promptly. Wash hands with soap and water when they are soiled or visibly dirty with blood or other body fluids (IB). Wet your hands, apply soap .and then scrub them vigorously for at least 15 s. Cover all surfaces of the hands and fingers.

WHO IS AT RISK?

- A weakened immune system, for example in elderly people, newborn babies and people with a long term health condition, such as type 2 diabetes
- An open wound
- A catheter or an intravenous drip

- A burn or
- Cut on the skin
- A severe skin condition, such as a leg ulcer or psoriasis surgery taking frequent courses of antibiotics.

ENVIRONMENTAL CONTROL

- Inmate housing areas and bathroom facilities should be regularly cleaned with an EPA registered detergent disinfectant according to the manufacturer's instructions.
- Recreational equipment, such as weight benches, should routinely be wiped clean after use with a clean dry towel.
- Inmates should use barriers to bare skin, such as a towel.
- Clean shirt, while using exercise equipment.

PREVENTION

- The best way to prevent the spread of S. aureus is for everyone to keep their hands clean.
- It is important to wash your hands properly.
- Health care workers and other hospital staff can prevent staph. Visitors also need to take steps to prevent spreading germs.
- If you have surgery planned, tell your health care providers
- If you have frequent infections.
- You have had a MRSA infection before. In recent years, rates of MRSA have fallen because of increased awareness of the infection by both medical staff and the public. However, MRSA still places a considerable strain on healthcare services.
- To reduce your risk of MRSA infection:
- Wash your hands before and after visiting someone in a care home (many hospitals provide an antibacterial gel in wards).
- If you are going into hospital for an operation, ask to be screened for MRSA.
- Speak to your nurse or doctor if you have any concerns about hygiene in your hospital.
- Put all disposable items, such as dressings, into the appropriate bins promptly.

PREVENTION FOR HOSPITAL STAFF

- Wash hands with soap and water when they are soiled or visibly dirty with blood or other body fluids (IB). Wet your hands, apply soap and then scrub them vigorously for at least 15 s. Cover all surfaces of the hands and fingers,

- Wash with water and then dry thoroughly using a disposable towel.
- Use an alcohol-based hand rub (IA) e.g. 0.5% chlorhexidine with 70% w/v ethanol, if hands are not visibly dirty. A combination of chlorhexidine and alcohol is ideal as they cover Gram-positive and Gram-negative organisms, viruses, mycobacteria and fungi. Chlorhexidine also has residual activity.
- During surgical hand preparation, all hand jewelleries (e.g. rings, watches and bracelets) must be removed.
- Finger nails should be trimmed to with no nail polish or artificial nails.
- Avoid wearing long sleeves, ties should be tucked in, house coats are discouraged and wearing scrubs is encouraged.

Follow standard precautions

Standard precautions include prudent preventive measures to be used at all times, regardless of a patient's infection status.

Sterile gloves should be worn after hand hygiene procedure while touching mucous membrane and non-intact skin and performing sterile procedures.

- Clean, non-sterile gloves are safe for touching blood, other body fluids, contaminated items and any other potentially infectious materials.
- Change gloves between tasks and procedures in the same patient especially when moving from a contaminated body area to a clean body area.
- Never wear the same pair of gloves for the care of more than one patient.
- Remove gloves after caring for a patient.
- Practice hand hygiene whenever gloves are removed.

Gown

- Wear a gown to prevent soiling of clothing and skin during procedures that are likely to generate splashes of blood, body fluids, secretions or excretions.
- The sterile gown is required only for aseptic procedures and for the rest, a clean, non-sterile gown is sufficient.
- Remove the soiled gown as soon as possible, with care to avoid contamination.

Wear a mask and adequate eye protection (eyeglasses are not enough), or a face shield to protect mucous membranes of the eyes, nose and mouth during procedures and patient care activities that are likely to generate splashes/sprays of blood and body fluids, etc.

- Patients, relatives and health care workers presenting with respiratory symptoms should also use masks (e.g. cough).

Patient-care equipment

- Used patient-care equipment soiled with blood, body fluids, secretions, or excretions should be handled carefully to prevent skin and mucous membrane exposures, contamination of clothing and transfer of microorganisms to, other patients or the environment.
- Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and sterilized appropriately.
- Ensure that single use items and sharps are discarded properly.

Follow transmission-based precautions

In addition to standard precautions, the following should be observed in those patients known or suspected to have airborne, contact or droplet infections:

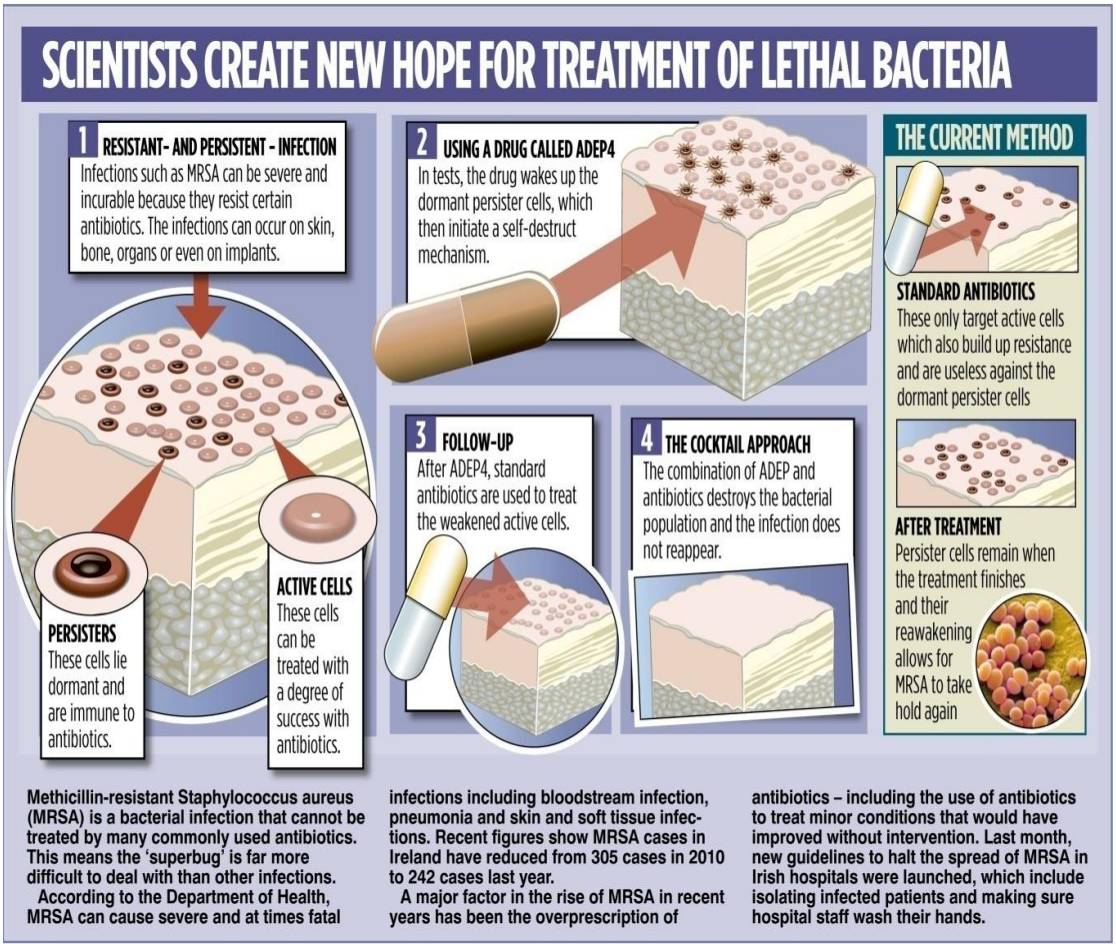
Airborne precautions

- Disease-causing microorganisms may be suspended in the air as small particles, aerosols, or dust and remain infective over time and distance, for example, *Mycobacterium tuberculosis* (pulmonary/laryngeal), varicella zoster virus (chickenpox), herpes zoster (shingles), rubella virus and measles.
- Isolate with negative-pressure ventilation.
- Respiratory protection must be employed when entering the isolation room .
- Use the disposable N-95 respirator mask, which fits tightly around the nose and mouth to protect against both large and small droplets. This should be worn by all persons entering the room, including visitors.

Contact precautions

Infections can be spread by usual direct or indirect contact with an infected person, the surfaces or patient care items in the room, for example, parainfluenza virus infection, respiratory syncytial virus infection, varicella (chickenpox), herpes zoster, and hepatitis A and rotavirus infections.

FUTURE PROSPECTUS



Scientists have discovered a new antibiotic that may help turn the tide against the rise of drug-resistant bacteria, or "superbugs". By using a method that grows bacteria in its native dirt rather than a lab dish, researchers from north eastern University in Boston were able to identify a new, promising antibiotic called teixobactin. When the researchers tested teixobactin in mice infected with the bacteria Methicillin-resistant Staphylococcus aureus (MRSA)—which causes infections in humans—they reacted favorably and cleared the infection. The scientists came across over 20 drug candidates, but teixobactin looks to be the most promising. New single-dose antibiotic may help battle superbug MRSA a single dose of a newly developed antibiotic may be just as effective as a longer course of standard antibiotics for the treatment of serious skin infections, including drug-resistant MRSA, which can be deadly.

The single dose of the new drug, called oritavancin, was found to cure MRSA, or methicillin-resistant Staphylococaus aureus, which typically requires a patient take antibiotics for up to 10 days and may involve a hospital stay.

"Oritavancin is unique in that because of its ability to stay in the body for long periods of time.

For the study, just published in the New England Journal of Medicine, researchers conducted a randomized trial in which 475 patients were given oritavancin and 479 received an infusion of the older antibiotic vancomycin twice a day for 7 to 10 days.

Corey and his team found a single dose of oritavancin worked as well as vancomycin. The new drug reduced the size of skin lesions by 20 percent or more within the first 48 to 72 hours, and cured patients at the same rate as the standard antibiotic.

Antibiotics are a miracle of modern medicine, but many patients find it difficult to tolerate a typical course of the drugs, which can last anywhere between three days to two weeks.

Patients can experience uncomfortable and debilitating side effects from the drugs, including gastrointestinal distress, yeast infections and allergic reaction. This often results in patients discontinuing their course of treatment, which has been shown to cause antibiotic resistance. Corey's study was funded by the Medicines Company, the drug company that owns the intravenous version of oritavancin. In February, the U.S. Food and Drug Administration accepted a filing of the new drug application.

According to Medicine Company's website, the FDA's action date for oritavancin is August 6, 2014.

FDA approves drug to treat MRSA

- FDA approves new drug to treat skin infections, including MRSA.
- CDC: MRSA infections have gone down in the U.S.
- Antibiotic-resistant infections are a big problem, WHO says,

The U.S. Food and Drug Administration has approved a new drug to treat bacterial skin infections like Methicillin-resistant Staphylococcus aureus, also known as MRSA.

MRSA is caused by a strain of staph bacteria that's become resistant to most antibiotics. It's life-threatening and is often found in hospitals and other health care settings. The new drug, called Dalvance, is taken intravenously. The drug is only approved for use in adults.

- **Hospitals getting better about MRSA**.

Antibiotic-resistant bacteria infect at least 2 million people each year, according to the CDC. The number of health care spread MRSA cases is declining, according to the Centers for Disease Control. But on any given day 1 in 25 hospital patients has at least one health care associated infection.

Most happen to patients who are not in intensive care units. That means you could go into the hospital for a knee surgery and end up leaving with a serious infection that normal antibiotics don't treat.

Protecting student athletes from MRSA

Staph infections typically start with small red bumps which can turn into painful abscesses that often require surgical draining.

The latest tool to fight MRSA, Dalvance, was approved after two clinical trials that included 1,289 adults with this kind of infection.

The adults were given Dalvance or another antibacterial drug. Dalvance was as effective as that drug for the treatment of this infection.

MRSA bacteria (above) was successfully treated by the new antibiotic. A new type of antibiotic that is capable of fighting off some superbugs has been discovered in the human nose.

The new drug, named lugdunin, originates from bacteria present in human nostrils. Importantly, it gave no indications of allowing the bacteria it attacks to mutate and develop resistance.

A human form of the drug has not yet been developed – it has only been tested on mice – but if successfully formulated, it would be a hugely significant scientific breakthrough.

Most existing antibiotics are sourced from the soil, where there is a constant war between different microorganisms. But lugdunin originated from a type of bacteria called Staphylococcus lugdunensis, which is found in about nine per cent of human noses.

Scientists from the University of Tübingen in Germany made the discovery while examining the Staphylococcus aureus bacteria, which can cause drug-resistant infections like MRSA.

In a healthy body, different bacteria in the body compete and keep each other in check, providing a balance. With this in mind, the researchers identified a specific gene in S. lugdunensis which could combat S. aureus in its various guises.

Using this gene, the scientists developed the antibiotic lugdunin. They used it on mice with skin lesions infected with S. aureus bacteria and found it cured the infection in both in the upper and deeper layers of the flesh.

Nanotechnology Based Solutions Against Superbug

The emergence of superbugs has made it imperative to search for novel methods, which can combat the microbial resistance. Thus, application of nanotechnology in pharmaceuticals and microbiology is gaining importance to prevent the catastrophic consequences of antibiotic resistance. Nanotechnology based approaches are advantageous to improve various preventive measures such as coatings and filtration. Similarly, diagnosis using efficient nanosensors or probes can speed up the treatment process at an early stage of disease.

Nano-based drug carriers for existing antibiotics enhance their bioavailability and make them more targets specific. Also the combination of nanoparticles (NPs) along with antibiotics makes them more lethal for micro-organisms.

Nanotechnology Based Approaches For Diagnosis For Superbugs

Although several conventional techniques with high sensitivity and reproducibility are available to detect MDR infections, they are cumbersome and time consuming. Nanoscience can offer various accurate, economical and less time-consuming methods, which will help to avert microbial spread and its consequences. A team of researchers from Jackson State University, USA has developed a new popcorn-shaped iron-magnetic core gold plasmonic shell nanoparticles for surface-enhanced Raman spectroscopy (SERS) detection and photothermal destruction of MDR Salmonella bacteria. They have also reported that the same core-shell nanoparticle can be used in combination with near infrared (NIR) light to form light-directed nanoheaters for hyperthermic destruction of MDR.

In another approach, the solution-based circuit chip (SCC) for simultaneous identification of resistant non-resistant *E. coli* causing urinary tract infections has been developed. These SCCs were fabricated by using a series of lithographic steps followed by electro-chemical deposition which creates 3-D nanoscopic morphology on microsensors. Further, these

patterned microsensors were functionalized with peptide nucleic acid (PNA) probes to target specific region of pathogens. This multiplexed technique is also capable of distinguishing different bacterial strains like *S. aureus* and *E. coli*.

CONCLUSION

Superbug resistance is escalating within the clinical setting and community at large. Most new antibiotics are chemical modifications of existing drugs and are quickly outsmarted by the bacteria in the environment. New antibiotics must be used with precision after the infectious organism is identified by culture and sensitivity testing. Using the exact antibiotic which specifically targets the identified organism is a key strategy to limit bacterial resistance.

In addition, health care providers must use all precautions to prevent spread of infection. Aggressive hand hygiene, use of gloves and gowns, patient isolation, and dedicated patient equipment are some of the recommended strategies. All health care providers, particularly in medical-surgical and critical care settings, need educational programs which disseminate information about new antibiotics and reinforce infection control procedures.

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