Bacteria, resistant to antibiotics

Antibiotic resistance is the ability of a microorganism to withstand the effects of an antibiotic. It is a specific type of drug resistance. Antibiotic resistance evolves naturally via natural selection through random mutation, but it could also be engineered by applying an evolutionary stress on a population. Once such a gene is generated, bacteria can then transfer the genetic information in a horizontal fashion (between individuals) by plasmid exchange. If a bacterium carries several resistance genes, it is called multiresistant or, informally, a superbug. Causes Antibiotic resistance can also be introduced artificially into a microorganism through transformation protocols. This can be a useful way of implanting artificial genes into the microorganism. Antibiotic resistance is a consequence of evolution via natural selection. The antibiotic action is an environmental pressure; those bacteria which have a mutation allowing them to survive will live on to reproduce. They will then pass this trait to their offspring, which will be a fully resistant generation.

Several studies have demonstrated that patterns of antibiotic usage greatly affect the number of resistant organisms which develop. Overuse of broad-spectrum antibiotics, such as second- and third-generation cephalosporins, greatly hastens the development of methicillin resistance. Other factors contributing towards resistance include incorrect diagnosis, unnecessary prescriptions, improper use of antibiotics by patients, and the use of antibiotics as livestock food additives for growth promotion.

Researchers have recently demonstrated the bacterial protein LexA may play a key role in the acquisition of bacterial mutations. Resistant pathogens Staphylococcus aureus (colloquially known as "Staph aureus" or a Staph infection) is one of the major resistant pathogens. Found on the mucous membranes and the skin of around a third of the population, it is extremely adaptable to antibiotic pressure. It was the first bacterium in which penicillin resistance was found—in 1947, just four years after the drug started being mass-produced. Methicillin was then the antibiotic of choice, but has since been replaced by oxacillin due to significant kidney toxicity. MRSA (methicillin-resistant Staphylococcus aureus) was first detected in Britain in 1961 and is now "quite common" in hospitals. Half of all S. aureus infections in the US are resistant to penicillin, methicillin, tetracycline and erythromycin.

This left vancomycin as the only effective agent available at the time. However, strains with intermediate (4-8 ug/ml) levels of resistence, termed GISA (glycopeptide intermediate Staphylococcus aureus) or VISA (vancomycin intermediate Staphylococcus aureus), began appearing the the late 1990s. The first identified case was in Japan in 1996, and strains have

since been found in hospitals in England, France and the US. The first documented strain with complete (>16ug/ml) resistence to vancomycin, termed VRSA (Vancomycin-resistant Staphylococcus aureus) appeared in the United States in 2002.

A new class of antibiotics, oxazolidinones, became available in the 1990s, and the first commercially available oxazolidinone, linezolid, is comparable to vancomycin in effectiveness against MRSA. Linezolid-resistance in Staphylococcus aureus was reported in 2003. CA-MRSA (Community-acquired MRSA) has now emerged as an epidemic that is responsible for rapidly progressive, fatal diseases including necrotizing pneumonia, severe sepsis and necrotizing fasciitis. Methicillin-resistant Staphylococcus aureus (MRSA) is the most frequently identified antimicrobial drug-resistant pathogen in US hospitals. The epidemiology of infections caused by MRSA is rapidly changing. In the past 10 years, infections caused by this organism have emerged in the community.

Enterococcus faecium is another superbug found in hospitals. Penicillin-Resistant Enterococcus was seen in 1983, Vancomycin-Resistant Enterococcus (VRE) in 1987, and Linezolid-Resistant Enterococcus (LRE) in the late 1990s. Streptococcus pyogenes (Group A Streptococcus: GAS) infections can usually be treated with many different antibiotics. Early treatment may reduce the risk of death from invasive group A streptococcal disease. However, even the best medical care does not prevent death in every case. For those with very severe illness, supportive care in an intensive care unit may be needed. For persons with necrotizing fasciitis, surgery often is needed to remove damaged tissue. Strains of S. pyogenes resistant to macrolide antibiotics have emerged, however all strains remain uniformly sensitive to penicillin.

Resistance of Streptococcus pneumoniae to penicillin and other beta-lactams is increasing worldwide. The major mechanism of resistance involves the introduction of mutations in genes encoding penicillin-binding proteins. Selective pressure is thought to play an important role, and use of beta-lactam antibiotics has been implicated as a risk factor for infection and colonization. Streptococcus pneumoniae is responsible for pneumonia, bacteremia, otitis media, meningitis, sinusitis, peritonitis and arthritis.

What is hospital-acquired infection?

A *hospital-acquired infection* (HAI), also known as a *nosocomial infection*, is an infection that is acquired in a hospital or other health care facility. According to *WHO* estimates, approximately 15% of all hospitalized patients suffer from these *infections*. During

hospitalization, patient is exposed to pathogens through different sources environment, healthcare staff, and other infected patients. Transmission of these *infections* should be restricted for prevention.

H*ospital-acquired infection microorganisms*

A nosocomial infection, also known as a hospital-acquired infection or HAI, is an infection whose development is favoured by a hospital environment, such as one acquired by a patient during a hospital visit, or one developed among hospital staff. Such infections include fungal and bacterial infections, and are aggravated by the reduced resistance of individual patients.

Known nosocomial infections include: Ventilator-associated pneumonia, Staphylococcus aureus, Methicillin resistant Staphylococcus aureus, Candida albicans, Pseudomonas aeruginosa, Acinetobacter baumannii, Stenotrophomonas maltophilia, Clostridium difficile, Tuberculosis, Urinary tract infection, Hospital-acquired pneumonia, Gastroenteritis, Vancomycin-resistant Enterococcus, Legionnaires' disease.

Methicillin-resistant Staphylococcus aureus (MRSA) is a bacterium responsible for several difficult-to-treat infections in humans. It is also called multidrug-resistant Staphylococcus aureus and oxacillin-resistant Staphylococcus aureus (ORSA). MRSA is any strain of Staphylococcus aureus that has developed resistance to beta-lactam antibiotics, which include the penicillins (methicillin, dicloxacillin, nafcillin, oxacillin, etc.) and the cephalosporins. Strains unable to resist these antibiotics are classified as methicillin-sensitive Staphylococcus aureus, or MSSA. The development of such resistance does not cause the organism to be more intrinsically virulent than strains of Staphylococcus aureus that have no antibiotic resistance, but resistance does make MRSA infection more difficult to treat with standard types of antibiotics, and thus more dangerous.

Suspectible Hosts

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Numerous risk factors in the hospital setting predispose a patient to infection. These risk factors can broadly be divided into three areas.

- People in hospitals are usually already in a ‘poor state of health’, impairing their defense against bacteria. Advanced age or premature birth, along with immunodeficiency (due to drugs, illness, or irradiation) present a general risk, while other diseases can present specific risks; for instance, chronic obstructive pulmonary disease can increase chances of respiratory tract infection.
- Invasive devices, for instance intubation tubes, catheters, surgical drains, and tracheostomy tubes all bypass the body’s natural lines of defense against pathogens and provide an easy route for infection. Patients already colonized at the time of admission are instantly put at greater risk when they undergo invasive procedures.
- Patients’ treatments can leave them vulnerable to infection: immunosuppression and antacid treatment undermine the body’s defences, while antimicrobial therapy (removing competitive flora and only leaving resistant organisms) and recurrent blood transfusions have also been identified as risk factors.

Prevention

Hospitals have sanitation protocols regarding uniforms, equipment sterilization, washing, and other preventive measures. Thorough hand washing and/or use of alcohol rubs by all medical personnel before and after each patient contact is one of the most effective ways to combat nosocomial infections. More careful use of antimicrobial agents, such as antibiotics, is also considered vital. Despite sanitation protocol, patients cannot be entirely isolated from infectious agents. Furthermore, patients are often prescribed antibiotics and other antimicrobial drugs to help treat illness; this can increase the selection pressure for the emergence of resistant strains.