



## A Review on Surgery and Antibiotic Susceptability

Bhargavi M<sup>\*1</sup>, Sarathchandiran I<sup>1</sup>, Kumar B<sup>2</sup>

<sup>1</sup>Department of Pharmacy, Sri Balaji Vidyapeeth University, Puducherry - 607403, Tamil Nadu, India

<sup>2</sup>Department of Pharmacy Practice, Ratnam Institute of Pharmacy, Nellore - 524346, Andhra Pradesh, India



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### ABSTRACT

Surgery is a branch of medicine which employs operations as a part in the treatment of disease or injury. Surgical procedures have been utilized for thousands of years, yet they have always been difficult to some degree for various reasons. Surgical operations are generally classified into one of five categories: time, procedure, body part, invasiveness, and equipment used. Antibiotics are the most common drugs used before, during and after surgery to prevent infections. Antibiotic prophylaxis, thus, is a preventative strategy based on strong surgical techniques, strict asepsis in the operating room, and infection control in the hospital/primary care medical practise. Antibiotics are used to prevent infection in individual patients based on their risk of surgical infection, the severity of the SSI effects, the efficiency of prophylaxis, and the consequences. Antibiotic resistance is more common on the overuse and inappropriate use of antibiotics. Antibacterial resistance or drug resistance is when a bacteria does not respond to drugs which were meant to kill or weaken them. At present situation the resistance is becoming major problem. It can be prevented by doing culture sensitivity test and by preparing antibiogram. An antibiogram is a tool that displays local microbiologic sensitivity information to help doctors make empiric judgments.

### \*Corresponding Author

Name: Bhargavi M

Phone: 8712240095

Email: bharsri6@gmail.com

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### INTRODUCTION

The branch of medicine that includes operations in the treatment of disease or injury is known as surgery. It involves cutting, abrading, suturing and any alterations in the tissues and organs of the body. It has been routinely used for many years,

but infection has always made it more difficult. Currently, surgery is an important element of the treatment of a variety of medical problems ([Collinsdictionary.com](http://Collinsdictionary.com), 2018; [Walker and Whittlesea](http://Walker and Whittlesea), 2012)

### Surgery Types

Surgical operations are divided into five categories as below:

#### Based on Timing

3 types of surgery are done based upon timing which includes:

1. Elective: It is mainly carried on patient's request and mainly for non-life-threatening condition.
2. Emergency: It is carried out as soon as possible to save a person's life, limb, or functional capacity.

3. Semi elective surgery: To avoid permanent disability.

### By Procedure Type

It consists of

1. Amputation: It entails the removal of a bodily component, generally a leg or digit.
2. Replantation: This procedure entails reattaching a severed part of body.
3. Reconstructive surgery: This type of surgery includes repairing a mutilated, injured, or deformed part of body.
4. Cosmetic surgery: Cosmetic surgery is used to improve the look of normal structures.
5. Transplant surgery: The insertion of a part of body or organ from a different human into a patient (or animal).

### By Part of Body

When a surgery is done on a single organ or structure, it is classified according to the organ, organ system, or tissue involved. GI surgery, heart surgery, and orthopaedic surgery are just a few examples.

### By Degree of Invasiveness

Invasive surgery, such as laparoscopic surgery or angioplasty, uses tiny exterior incisions to insert miniature equipment into a cavity of body or structure.

### By Equipment Used

It entails tissue cutting using a laser. Microsurgery entails the surgeon using an operating microscope to examine tiny structures ([Collinsdictionary.com](http://Collinsdictionary.com), 2018).

### Surgeries

Wound infections is always been a problem in the field of surgery. Because of development of resistance the problem in advances of infection control have not completely eradicated. Most bacteria living on our skin, in the nasopharynx region, in gastrointestinal tract and other parts of the body, have little potential for causing disease because of first line defense mechanism within the body. But diseases, surgical operation, burns, trauma, nutrition and other factors affect this defences ([Anguzu and Olila, 2007](#)) (Table 1).

### Antibiotic Prophylaxis

Antibiotic prophylaxis is one of the components of a preventative approach that includes strong surgical skill, aseptic operating theatre conditions, and

hospital infection control. Antibiotics are used to prevent infection in a specific patient. Antibiotics are prescribed based on the patient's risk of surgical infection, the severity of the SSI's effects, the efficacy of prophylaxis, and the consequences of prophylaxis ([Walker and Whittlesea, 2012](#); [Munckhof, 2005](#)).

### Antibiotic Selection for Prophylaxis

1. Antibiotics given for prophylactic treatment should be active against the most likely infecting organism.
2. Antibiotics may also be applied topical, systemic or enteral.
3. Antibiotics with minimal toxicity and a low prevalence of allergies should be employed in the selection of pathogenic pathogens.
4. To reach appropriate tissue concentration, it should be given 30 minutes before to incision.
5. A single dosage is less expensive and better since it reduces the chance of bacterial resistance development ([Holzheimer, 2001](#)) (Table 2).

### Infection

In humans, an infection is caused by the invasion of foreign cells such as bacteria that damage the host organism. Cells that do not belong to the host organism are said to have "colonised" it. In order for colonisation, which is referred to as infection, these alien cells may be detrimental to the host organism. Infections can be caused by a variety of causes. Viruses, parasites, and fungus, in addition to bacteria, can cause difficulties for a host organism.

### Antibiotics

Antibiotics a chemical substance which is produced by a microorganism that is useful for inhibiting the growth or kills the other microorganisms.

### Antibiotic Resistance

Antibiotic resistance is caused by the misuse and overuse of antibiotics. Bacteria that were formerly vulnerable to antibiotics have evolved resistance to the medicines designed to kill or weaken them. This is referred to be antibacterial or medication resistance ([Hugo and Rusell, 1998](#)).

Antibiotic resistance can be reduced using a variety of strategies below:

1. Using of narrow spectrum agents.

**Table 1: Type of Surgeries with Definitions**

Types of Surgeries	Definition
Appendicitis ( <a href="#">WebMD, 2020</a> )	Appendicitis is an inflammation of the appendix.
Herniotomy ( <a href="#">Offline Clinic, 2012</a> )	Hernia repair refers to a surgical operation for the correction of a hernia.
Hydrocelectomy ( <a href="#">Thefreedictionary, 2020</a> )	Hydrocelectomy is a surgical procedure performed to correct a hydrocele.
Caesarean surgery ( <a href="#">Womenshealth.gov, 2017</a> )	A caesarean section is a surgical procedure in which one or more incisions are made through a mother's abdomen and uterus to deliver one or more babies.
Orthopaedic surgery	Orthopaedic surgery is the branch of surgery that deals with musculoskeletal problems.
Laproscopy ( <a href="#">MedlinePlus, 2009</a> )	Laparoscopic cholecystectomy is the most common laparoscopic procedure performed.
Lumpectomy ( <a href="#">Breastcancer.org, 2020</a> )	A lumpectomy is the surgery used to treat breast cancer
Hysterectomy ( <a href="#">Van Eyk and van Schalkwyk, 2012</a> )	It is a surgical removal of the uterus.
Tubectomy ( <a href="#">Wagh et al., 2006</a> )	Tubectomy or female sterilization is the most popular method of contraception in India.
Tympanoplasty ( <a href="#">John et al., 1988</a> )	It is the surgical operation performed for the reconstruction of the eardrum and or the small bones of the middle ear.
Tonsillectomy ( <a href="#">Veltri et al., 1972</a> ; <a href="#">Telian et al., 1986</a> )	It is a surgical procedure in which each tonsil is from a recess in the side of the pharynx called the tonsillar fossa.
Cataract ( <a href="#">Govaerts et al., 1998</a> )	Cataract surgery involves the removal of the natural lens in eye, that has developed an opacification, which is referred to as a cataract.
Mastectomy ( <a href="#">Mayoclinic.org, 2020</a> )	It is a procedure in which breast tissue is removed from a breast in order to cure or prevent breast cancer.

- Non-infections should not be treated with antibiotics.
- Short courses should be used at the right time.
- For serious infections, avoid using last-line antibiotics and only take them if other options aren't working.
- Surveillance of usage of antibiotics, quantities used and their resistance.

## Culture Sensitivity Test

### Sampling Procedure

Before the wound was cleaned using an antiseptic solution, pus swabs were aseptically obtained from surgical sites. The specimen was collected on sterile cotton swab without contaminating them. After obtaining the samples, they were transported to the laboratory.

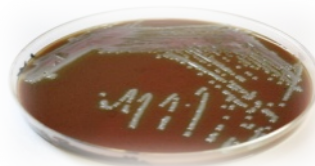
In the laboratory, the specimens were registered and macroscopically examined for their appearances. The swabs were cultured and smears

were made on clean slides for gram staining techniques ([Anguzu and Olila, 2007](#)).

### Preparation of Agar Plates

#### Chocolate Agar Base

27 grams (for 20 petri dishes) of chocolate agar base mixed with 300 ml of millipore water along with 6 grams of agar. Keep the solution for sterilization for 20 minutes. Then pour this solution to previously sterile petri dish in a complete sterile area. Allow the solution to solidify (Figure 1).



**Figure 1: Chocolate Agar Base**

#### Macconkey Agar

16.5 grams (for 20 petri dishes) of macconkey agar is mixed with 300 ml of water along with 6 grams of

**Table 2: Antibiotic Prophylaxis in Specific Procedures**

Types of Surgery	Bacterial Species	Antibacterial Agents
Hygienic surgery	Staphylococcus aureus	First-generation cephalosporins
Thyroid gland, mammary gland, Cardiovascular surgery	Coagulase-negative staphylococcus	Combination of penicillins (ampicillin/cloxacillin) with b-lactamase inhibitors
Upper gastrointestinal surgery, Gastrectomy	Gram-negative bacilli that are aerobic (mainly, Escherichia coli, and occasionally, Klebsiella pneumoniae)	First-generation cephalosporins, Second-generation cephalosporins In some situations of gastrectomy, penicillins can be utilised.
Appendectomy (non-perforating)	Aerobic gram-negative bacilli (mainly, e. Coli)	Cephamycins, oxacephems, penicillins
Hepatobiliary surgery	Aerobic gram-negative bacilli (E. coli, K. pneumoniae, Enterobacter species), Staphylococcus species	First- and second-generation cephalosporins, penicillins
Thoracic	S. Epidermidis, S. Aureus	Cefazolin
Gastroduodenal	Gram-positive cocci, enteric gram-negative bacilli	Cefazolin
Breast and hernia	S. epidermidis, S. aureus	Cefazolin
Colorectal surgery	Aerobic gram-negative bacilli	Cephamycins (cefmetazole) Oxacephems (flomoxef) ( <a href="#">Japanese Society of Chemotherapy Committee on guidelines for treatment of anaerobic infections</a> , & <a href="#">Japanese Association for Anaerobic Infection Research, 2011</a> ; <a href="#">Holzheimer, 2001</a> )

agar. Keep the solution for sterilization for 20 minutes. Then pour this solution to previously sterile petri dish in a complete sterile area. Allow the solution to solidify (Figure 2).



**Figure 2: Macconkey Agar**

**Nutrient Agar**

13.3 grams (for 20 petri dishes) of nutrient agar is mixed with 300 ml of millipore water along with 6 grams of agar. Keep the solution for sterilization for 20 minutes. Then pour this solution to previously sterile petri dish in a complete sterile area. Allow the solution to solidify (Figure 3).

**Blood Agar**

30 ml of human blood is collected and transferred

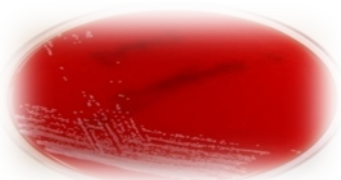


**Figure 3: Nutrient Agar**

to a 500 ml sterile beaker contains previously sterile glass beads. Then allow the beaker to rotate on a speed of 200 rotations for 20 minutes on a centrifuge. After 20 minutes the fibrin gets separated and defibrillated blood is separated. Then mix this defibrillated blood with agar base and pour to previously sterilized petri dish in a complete sterile area. Allow the solution to solidify ([Arun et al., 2013](#)) (Figure 4).

**Staining Reactions**

Staining is a simple, fundamental technique for identifying microbes. The morphology of microorganisms is typically studied using simple staining. Methylene blue or basic fuchsin are used in the



**Figure 4: Blood Agar**

simple stain. The bacterial cell's strong -ve charge will firmly connect with the +ve charged basic dyes, imparting colour to all bacteria (Value @ Amrita, 2019).

### Biochemical Reactions

Bacterial colonies can differ greatly in their morphologies. These differences can help in identifying different species of bacteria. Bacterial species differ in their cellular morphologies and staining properties are used in identifying different species. Generally, selective and differential media rely on some structural or metabolic property of the species that is preferentially selected.

However, most of these tests are not extremely specific. Gram staining allows us to distinguish gram positive and gram negative organisms and rod-shaped organisms from coccus-shaped organisms, but does not allow us to make a more specific identification. Likewise, a selective and differential medium like macconkey allows to identify gram negative, lactose fermenting organisms, but does not allow to positively identify what specific gram negative, lactose fermenting organism are being examining. Microbiologists have devised a set of biochemical assays that may be used to distinguish even closely related bacteria for conclusive identification.

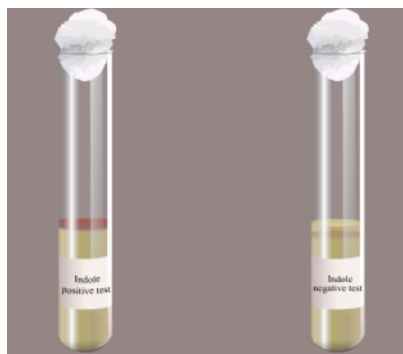
In the contamination of food, gram negative enteric bacilli plays an important role. Hence these are the main causative agents of intestinal infection. Gram negative family includes salmonella, shigella, klebsiella, proteus, enterobacter, escherichia etc. Usually four tests are used for differentiation of the various members of Enterobacteriaceae. They are indole test, methyl red test, Voges Proskauer test and citrate test; collectively known as imvic series of reactions (Value @ Amrita, 2019).

### Indole Test

Indole tests is for looking the presence or absence of tryptophanase enzyme used in production of the bacteria. If the enzyme is present, it will degrade the amino acid tryptophan in the media and will produce indole, ammonia and pyruvic acid.

Indole will react with kovac's reagent to produce a cherry red complex, which indicates a positive indole test.

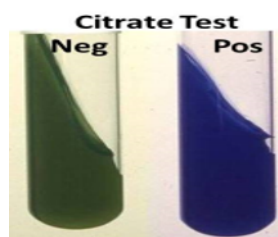
The absence of red color is indicative of tryptophan hydrolysis due to the lack of tryptophanase enzyme (Figure 5).



**Figure 5: Indole Test**

### Citrate Utilization Test

This test is used to assess a microorganism's capacity to utilise citrate. Some bacteria have the capacity to convert organic acid salts, such as sodium citrate, into alkaline carbonates. Krebs's cycle metabolite sodium citrate is one of the most significant. Citrate is the only carbon source for certain bacteria. Citrate use necessitates the presence of a particular membrane transporter as well as citrate lyase activity. Citrate lyase converts citrate to oxaloacetic acid, which is then transformed to pyruvate with the emission of carbon dioxide by oxaloacetate decarboxylase activity. Sodium carbonates are formed when carbon dioxide interacts with sodium and water (Figure 6).



**Figure 6: Citrate Test**

### Antibacterial Susceptibility Testing

Susceptibility testing was mainly performed by kirby-bauer technique. The test organism was uniformly seeded over the mueller-hinton agar surface and exposed to a concentration gradient of antibiotic diffusing from antibiotic-impregnated paper disk into the agar medium. For 24 hours the isolate was incubated at 37°C. Organisms sensitive to the antibiotic were inhibited from growing in a circular zone around the antibiotic impregnated paper disk. A comparison of the inhibition zone diameter that was produced by a control strain was used to interpret the antimicrobial sensitivity (Holzheimer, 2001).

## Antibiogram

Antibiogram is a technology that displays local microbiologic sensitivity data to help doctors make better accurate judgments. Antibiograms have mostly been used in hospitals to uncover significant local resistance trends and to enhance antibiotic prescription for acute illnesses.

Antibiotics are routinely administered in clinical practise based on general principles and knowledge of sensitivity. Many bacteria, however, are known to be resistant to a variety of medicines, making treatment difficult. This is especially true for fragile patients, such as those in the intensive care unit. Bacteria such as *pseudomonas aeruginosa* may be involved when these individuals develop "hospital-acquired" (or "nosocomial") pneumonia. Treatment is then usually begun based on surveillance data regarding the local pathogens that are most likely to be implicated. The first therapy, empirical treatment, is based on statistical data from previous patients and is directed at a wide group of possibly implicated microorganisms.

## CONCLUSION

Surgery is an aspect that can happen at any stage in our life. So all should have awareness of different types of surgeries. Antibiotics usage plays a crucial role in surgery and for eradicating infections carried before, during or after surgery. Before using an antibiotic one should check the suitable antibiotic by conducting culture sensitivity test. The need of developing antibiogram is crucial in order to have a clear cut idea on which antibiotics should be used for which type of bacteria.

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## Conflict of Interest

The authors declare that there is no conflict of interest.

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