CHAPTER 1

History of Surgery, Sterilisation and Surgical Patient

History of Surgery
- Ancient period
- Medieval period
- Modern period

Sterilisation and Disinfection
- Physical agents
- Chemical agents
- Autoclaving
- Gases
- Surface-active agents

Surgical Patient

HISTORY OF SURGERY

Ancient Period

INDIA: ***Ayurveda is the name for ancient Hindu medicine.*** The origin of Ayurveda has been traced to Vedic times, about 5000 BC. Dhanwanthari is called the father of ayurvedic medicine. Application of bone prosthesis, concepts of wound healing, ligation of bleeders and knowledge of instruments were known to the treating Vaidyas (doctors). Sushrutha is called the father of Indian surgery. His book *Sushruta Samhita* written in 1500 BC also describes various instruments and operations. Cutting of the nose and ears was a type of punishment in olden days. Hence the reconstruction of these organs was required. The result is ancient Indian rhinoplasty. It was very popular.

EGYPT: Civilization which took place along the Nile Valley also had a good knowledge about wound, case histories and even trephination[1] of skulls. All this information was written in ***leaf of papyrus*** plant which is still preserved. ***King Hammurabi*** laid the code of conduct for the treatment and to the surgeons. For wrong treatment surgeons were punished by severing their hands.

CHINA: A few books are available describing physical signs, examination of pulse and acupuncture.

GREECE AND ROME: Hippocrates, known as the father of medicine and surgery was from an island of Cos. The description of amputation and treatment of ulcer and fistula are present in corpus Hippocratica. The body of writing attributed to Hippocrates, the *Hippocratic Corpus*, is a collection of roughly 70 works that show no uniformity in teaching or in prose style. With a few exceptions, the dates of these works range between 450 and 350 BC. They are the oldest surviving complete medical books. *Corpus* contains concepts about acute diseases, epidemics and regimens. Hippocratic oath is one of the parts of the corpus. Galen, a Greek physician, was the first to do anatomical dissection of cadavers. He had done a lot of experiments on animal and conducted cataract surgery.

Medieval Period

- There was a decline in surgery in India and Europe during this time. Because of growing Buddhism and the message of non-violence (ahimsa), many people considered surgery as 'demoniacal' or asuri medicine.

[1]Trephination: Removal of circular piece of cranium using a trephine

- However, during this period Arabs and Muslims entered the intellectual arena. Between the 7th and 15th centuries, they made considerable contributions to the field of surgery like building hospitals (e.g. first hospital in Baghdad), writing books, etc.
- In Spain, many hospitals came into existence in this period. Treatment of empyema, pericarditis and hysterectomy was done for the first time.

Modern Period

1514–1564: **Andreas Vesalius,** born in Brussels, professor of anatomy and surgery at Padua in Italy, published his first anatomy text called *Fabrica*. (This was possible because of printing press.) He emphasised for the first time that anatomy can be learnt only by dissecting human body not animal body. He was the first to put forth the concept of 'hands-on' education. Knowledge of anatomy strengthened surgery.

1510–1590: **Ambroise Pare** was trained as barber surgeon. He served in the military of France as army surgeon. He played the major role of updating old fashioned surgery and concepts. He represented the severing of the final link between surgical thought and techniques of the ancient and push towards modern era. He innovated the use of ***turpentine oil in gunshot wound dressings.*** He felt that individual vessels should be ligated rather than mass ligation for amputations. He always said, ***"I treated him. God cured him".***

1728–1793: **John Hunter** was a surgeon, anatomist, physiologist, pathologist and experimentalist (Key Box 1.1). He is described as the father of modern science of surgery. He was considered to be one of the most influential surgeons of all times. He was Scottish.

1800: King George III chartered the Royal College of Surgeons of London.

JOHN HUNTER **KEY BOX 1.1**

1. First ligated a case of aneurysm and demonstrated that collaterals will develop and limb can be saved.
2. Gave the idea of tissue preservation
3. Introduced study of surgical pathology
4. Adductor canal in the thigh is in his name—Hunter's canal
5. Worked vigorously on venereal diseases like syphilis and gonorrhoea.
6. Hunterian chancre in syphilis
7. Did transplantation of a spur in Cock's comb
8. Great teacher
9. Collection of more than 13,000 specimens—Hunter's collection is housed in England's Royal College of Surgeons' museum. Unfortunately Nazi bombing attack of London in World War II destroyed most of Hunter's assemblage.

1843: Queen Victoria chartered the Royal College of Surgeons of England.

1827–1912: **Joseph Lister** introduced the present day concept of asepsis and antisepsis. ***He introduced for the first time carbolic acid as an antiseptic for destroying bacteria.*** Carbolic acid (phenol) had been in use as a means of deodorizing sewage. So, Lister tested the results of spraying instruments, the surgical incisions, and dressings with a solution of it. Lister found that carbolic acid solution swabbed on wounds markedly reduced the incidence of gangrene and subsequently published a series of articles on the ***Antiseptic Principle*** of the ***Practice of Surgery*** describing this procedure on 16 March 1867 in the journal ***The Lancet.*** He also sprayed carbolic acid in the operation theatres and around the operation table. He dipped his hands in phenol solution and corrosive sublimate. He developed sterile absorbable sutures so that they can be left deep inside the wound. Earlier after suturing at depth, these sutures were brought outside which will be removed at a later date. He said for the first time ***"laudable pus in fact is not laudable but due to some organisms".*** Thus, Listerism became popular and acceptable among

German-speaking surgeons. The late 19th century saw developments in the direction of asepsis and antisepsis in the form of boiling, autoclaving, wearing of sterile gowns, drapes, gloves, hats, masks and caps, etc. ***He also made surgeons wear clean gloves and wash their hands before and after operations with 5% carbolic acid solutions.*** It should be noted that he first persuaded Charles Goodyear[1] to manufacture rubber gloves for his nurse since the carbolic acid caused her to suffer from contact dermatitis. Instruments were also washed in the same solution and assistants sprayed the solution in the operating theatre. One of his conclusions was to stop using natural porous materials in manufacturing the handles of medical instruments.

1822–1895: Louis Pasteur was a French scientist. He discovered microbes and putrefaction. He reasoned out this could be the cause for pus. ***Pasteurization of milk was a landmark concept.*** This has largely decreased milk-borne diseases including tuberculosis.

1929: **Landsteiner made** discovery of blood groups. This lead to further development of blood banks and storage which helped surgery to grow further.

Spenser wells devised haemostat-artery forceps.

Antibiotics

Paul Ehrlich was a German who wanted to treat and cure syphilis; he developed "salvarsan 606".

Alexander Fleming accidentally discovered penicillin in 1928 and heralded a new era in chemotherapy.

Radiology

1895: **Roentgen** discovered X-rays.

1901: **Walter Cannon** discovered fluoroscopy when he was a medical student.

[1]Goodyear is name of the person who manufactured Goodyear rubber tyres.

Surgery of Body Cavities

- Technique of suturing slowly developed and surgeons started resections and anastomosis of various structures (hollow tubes).
- Wilkie removed the first inflamed appendix (Wilkie's syndrome).
- Bassini and Halsted contributed for hernia repair.
- Billroth, a great Viennese surgeon, operated on gastric cancer.
- Antoine Lambert is famous for his 'in and out' and 'out and in' inverting sutures for gastrojejunostomy.
- Charles McBurney of America described the famous incision for appendicectomy in 1889.
- Lord Moynihan of Leeds did a lot of work on gallbladder stones.

To conclude, evolution of surgery has taken more than 2000 years. What is practised today is evidence-based medicine. Surgery has become safe today. Results of surgery are good in good hands. It means proper training and coaching of a surgeon.

STERILISATION AND DISINFECTION

In spite of scientific advances in understanding pathogenesis of various diseases and better understanding of pharmacotherapy, infection remains the 'number one' enemy for surgeons. So, every attempt should be made to minimise the infection rates in the ward, hospital and in the operation theatre. Joseph Lister called infective agents as disease dust and introduced carbolic acid spray as an antiseptic agent. Hence, ***Joseph Lister is called the father of modern surgery.*** This chapter deals with fundamental principles of various methods of sterilisation and disinfection and their usage in day to day clinical practice.

Sterilisation is defined as a process by which an article, object or surface is free of ***all microorganisms in the vegetative form and in***

the spore state. This includes viruses, bacteria, their spores and fungi.

Disinfection means destruction of all pathogenic organisms capable of giving rise to infection. Rarely does this process kill spores. Disinfection must never be used when sterilisation is possible.

Antisepsis means prevention of infection by inhibiting the growth of bacteria in wounds or tissues.

Agents used in Sterilisation

Key Box 1.2 gives the classification of agents used in sterilisation.

KEY BOX 1.2

CLASSIFICATION

Physical agents	Chemical agents
1. Sunlight	1. Alcohol
2. Drying	2. Aldehyde
3. Heat	3. Dye
– Dry heat	4. Halogens
– Moist heat	5. Phenols and cresols
4. Filtration	6. Gases
5. Radiation	7. Surface-active agents
	8. Metallic salts

Physical Agents

1. Sunlight

It is an example of a natural bactericidal agent which causes sterilisation of tank water, rivers, etc. It is mainly because of ultraviolet rays in addition to heat rays.

2. Drying

Drying in air has ill-effects on growth of bacteria. In fact, 80% of weight of bacteria is due to water. However, it does not affect spores and it is an ***unreliable*** method.

3. Heat

Heat is the most commonly employed and most reliable method of sterilisation (Key Box 1.3).

KEY BOX 1.3

HEAT

- Most reliable
- Rapid method of sterilisation
- No harmful residue

Two types

- Dry heat
- Moist heat

Dry heat: This method of heat kills the organisms by protein denaturation and oxidative damage.

Types

a. Red heat: Inoculating loop or wires, tip of forceps and needles are held in the flame of a Bunsen burner till they become red hot.

b. Flaming: Glass slides, scalpels and mouths of culture tubes are passed through Bunsen flame a few times.

c. Incineration: This is used to destroy soiled dressings, bedding, bandages, etc.

d. Hot air oven is the most widely used method of sterilisation by dry heat (Key Box 1.4).

- Temperature required is 160° C for one hour or 180° C for 20 minutes.
- Glassware, forceps, scissors, scalpel glass syringe can be sterilized. Materials like oils, greases, dry powder, etc. can also be sterilized by this method.

KEY BOX 1.4

HOT AIR OVEN

- Glass syringes, test tubes, pipettes
- Metal forceps, scissors, scalpels
- Oil, jelly, powder
- Swab sticks

Sterilisation control-indicators

1. Spores of nontoxigenic strain of *Claustridium tetani*
2. Browne's tube
3. Thermocouples.

Moist heat: This method of heat kills organisms by coagulation and denaturation of their proteins.

In cases of spores, steam condenses on it, increases its water content, causes hydrolysis and breakdown of the bacterial protein.

Types

A. At temperature below 100° C

a. Pasteurisation: Temperature of 63° C for 30 minutes (holder method) or 72° C for 15 to 20 seconds (flash method), followed by cooling quickly to 13° C or lower. Mycobacteria, brucellae and salmonellae are destroyed by this method but spores are not destroyed.

b. Inspissation: Serum or egg media (Lowenstein-Jensen's media) are sterilized in the inspissator at 80–85° C for half an hour on three consecutive days.

c. Vaccine bath: Vaccines of nonsporing bacteria are sterilised in special vaccine baths at 60° C for one hour.

B. At 100° C

a. Boiling (temperature 100° C): Vegetative bacteria are killed at 100° C but sporing bacteria require considerable time for boiling. Hence, boiling is not recommended for sterilising instruments.

b. Tyndallisation: Steam at 100° C for 20 minutes on three consecutive days. It is used for sterilisation of egg, serum or sugar containing media.

c. Autoclaving or steam under pressure (temperature above 100° C): This is the most popular method.

Principle: Water boils when its vapour pressure equals that of surrounding atmosphere. When pressure inside a closed vessel increases, the temperature at which water boils also increases. When steam comes into contact with cooler surface, it condenses to water and gives up its latent heat to that surface. Condensed water ensures moist conditions for killing the microbes present. All the air must be removed from autoclave chamber before autoclaving.

KEY BOX 1.5

STEAM ABOVE 100° C—ADVANTAGES

- Greater lethal action of moist heat
- Quick action
- Penetrates porous materials such as linen, paper and cloth wrappers, cotton wool stoppers

Temperature employed: Sterilisation is carried out between 108° C and 147° C. Commonly, temperature of 121° C at 15 lb pressure for 15 minutes is used (Key Box 1.5).

- Thus dressings, instruments, laboratory-ware, media can be sterilised with autoclaving. However, it is not suitable for bottled fluids.

Sterilisation control: Spores of *Bacillus stearothumophilus* are used as test organism.

- Chemical indicators: Browne's tubes
- Thermocouples
- Autoclave tapes.

4. Filtration

It is used to get rid of microorganisms from heat labile liquids and substances such as sugars and urea, which are used for preparation of media. Hence it is useful for antibiotic solutions, sera and carbohydrate solutions used in the preparation of culture medium. Different types of filter include earthenware filters, asbestos filters, sintered glass filters, membrane filters, etc.

5. Radiation

a. Nonionising radiation: Low energy type, for example

1. *Infrared radiation:* Used for mass sterilisation of syringes.

2. *Ultraviolet radiation:* This can be used to disinfect hospital ward, operation theatre, viral laboratory, etc.

b. Ionising radiation: X-rays, gamma rays are examples. They have high penetration power and highly lethal to all cells including bacteria. ***Gamma radiation is used to sterilise plastic tubes, catheters, syringes, culture plates, etc.*** This method is also known as ***cold sterilisation,*** as there is no appreciable increase in the temperature.

Chemical Agents

Chemical agents act by protein coagulation and disruption of cell membrane. They are mainly used for disinfection rather than sterilisation.

Disinfectants are antimicrobial agents used to kill potentially infectious agents present on inanimate object, e.g. surfaces, water, etc.

Chemical disinfectants which can be safely applied to skin or mucous membrane and are used to prevent infection by inhibiting the growth of bacteria are called *antiseptics*.

1. Alcohols

Ethyl alcohol (ethanol) and isopropyl alcohol are commonly used. They rapidly kill bacteria, including tubercle bacilli, but they have no action on spores and viruses. They are used in concentration of 60–70% in water as skin antiseptics before a surgical incision.

- ***Isopropyl alcohol*** is better than ethanol because it is fat solvent, more bactericidal and less volatile. Hence, it is used to disinfect clinical ***thermometers.***
- Methyl alcohol is effective against fungal spores. However, it is ***toxic*** and inflammable and hence, not used.

2. Aldehydes

They are bactericidal and sporicidal.

1. ***Formaldehyde (HCHO):*** This is used to preserve anatomical specimen. It is an irritant, water-soluble gas.
   - Formaldehyde gas is used to fumigate wards, sick rooms, etc.
2. ***Glutaraldehyde:*** It is effective against ***tubercle bacilli, fungi and viruses.*** It is less irritant than formaldehyde.
   - This is used to sterilise cystoscopes, bronchoscopes, endotracheal tubes and metal instruments, which are heat-sensitive.
   - 2% buffered solution is used.
   - It has ***no deleterious effect on cement or lenses of instrument.***
   - Commercially available as 'Cidex'.

3. Dyes

- They are aniline dyes (Key Box 1.6) and acridines which are used as skin and wound antiseptics. Acriflavine, proflavine are the examples for acridine dyes.
- They act against gram-positive and gram-negative organisms. They are little, if at all, affected by presence of pus.
- Whenever a cavity has to be packed or a tie over dressing to be applied following skin grafting, gauze soaked in acriflavine can be used.

KEY BOX 1.6

ANILINE DYES

- Brilliant green, malachite green, crystal violet
- More active against gram positive organisms
- Pus inhibits their activity

4. Halogens

Iodine is a bactericidal agent with moderate activity on spores. It is also active against tubercle bacillus. Iodine is used almost exclusively as a skin disinfectant (antiseptic).

- Mixtures of iodine with surface-active agents that act as carrier for iodine are known as ***iodophores.*** Betadine is an example of this. This is also active against fungi, trichomonas.
- When chlorine or hypochlorites are added to water, the chlorine reacts with water to form hypochlorous acid. It is a strong oxidizing agent and effective disinfectant.

- Chlorine and hypochlorite solution (EUSOL) also are other examples.

5. Phenols and cresols

These are obtained by distillation of coal between temperatures of 170° C and 270° C. They cause cell membrane damage.

- Phenol (carbolic acid) was introduced first by Lister, father of antiseptic surgery. It is a powerful microbicidal substance. It is bactericidal at a concentration of 1%.
- Lysol, cresols, chlorhexidine are also phenols. Chlorhexidine (hibitane) is nontoxic, skin antiseptic, active against gram positive and also gram negative organisms and moderately active against mycobacteria.

6. Gases (vapour-phase disinfectants)

1. ***Ethylene oxide:*** It is highly inflammable colourless gas. Hence, it is mixed with inert gases such as carbon dioxide or nitrogen so that its explosive tendency is eliminated. It is highly lethal to all kinds of microbes including spores and tubercle bacilli.
   - It is used for sterilising heart-lung equipment, books, clothing, glass, plastic, etc. Thus routinely used catheters such as Foley's catheters, Ryle's tube, etc. are sterilised by ethylene oxide gas.
2. ***Formaldehyde gas:*** Used for fumigation of operation theatres and rooms, often after doing septic case.
3. ***Betapropiolactone:*** It is also used for fumigating purposes. It is also active against viruses.

7. Surface-active agents

Substances that alter energy relationships at interfaces leading to reduction of surface or interfacial tension are known as surface-active agents or surfactants. They are used as wetting agents, detergents, etc.

- The most commonly used preparations are cationic surface-active agents. They are bactericidal. They have no action on spores, tubercle bacilli, etc. Commercially available preparation include cetrimide (cetavalon). They are most active in alkaline pH. *Pseudomonas aeruginosa* is particularly resistant to these compounds.
- Soaps are also active against gram positive and negative organisms.

8. Metallic salts

The salts of silver, copper and mercury are used as disinfectants. Mercurochrome is less toxic and is used as mild antiseptic.

Clinically it is used in the treatment of skin grafted ulcers after the graft has taken up well.

KEY BOX 1.7

QUICK REVISION OF STERILISATION OF COMMONLY USED INSTRUMENTS IN THE OPERATION THEATRE

• Surgeon's knife (scalpel)	:	Glutaradehyde
• Forceps, retractors, etc.	:	Hot air oven
• Foley's catheter	:	Gas sterilisation (ethylene oxide)
• Glass syringes	:	Hot air oven
• Operation theatre	:	Formaldehyde gas
• Clinical thermometer	:	Isopropyl alcohol

Testing of Disinfectants

1. ***Rideaol Walker test:*** Phenol is taken as standard disinfectant. Suspension of typhoid bacilli is subjected to the action of varying concentrations of phenol and the disinfectant to be tested and compared with phenol.
2. ***Chick Martin test:*** Disinfectant acts in presence of organic matter.

PROCEDURE OF A PATIENT UNDERGOING SURGERY

Admission

A patient who requires a surgical procedure that needs to be done under general or regional

anesthesia is admitted 1–2 days before the procedure. Admission is necessary to assess his fitness before surgery, provide him with adequate preoperative care, appropriate medication to optimally control his other medical conditions such as diabetes, asthma, cardiac conditions, etc.

In the Ward

Patient is also seen and examined by duty doctors (may be a postgraduate or teaching faculty) and complete case record is written (case sheet). Generally in a medical college it is written by interns. The patient is also given proper medication, if required, e.g. treatment of hypertension or diabetes or asthma, etc. If a patient has serious comorbid medical conditions, he will be seen by cardiologists and anesthesiologists so that preoperative optimization is done to decrease the risks of surgery, e.g. patient had myocardial infarction 1 year back and he has come for laparoscopic gallbladder removal (lap cholecystectomy). Such moderate to high risk patients are seen well in advance by the concerned department may be as outpatient or as an inpatient so as to decrease the risks involved in surgery.

Premedication

A patient who is undergoing surgery will have a lot of anxiety, apprehension, worries etc. Hence, drugs are administered previous night which will help in smooth transfer of the patient to the operation theatre (OT).

In the Operation Theatre

1. Patient will be anesthetised by anesthesiologists.
2. Surgeons and nursing staff will ***scrub (hand wash)*** for a minimum of 3 minutes. Scrub solutions include chlorhexidine solution, povidone iodine, etc. This simple method of washing before surgery will decrease the contamination of the surgical site by bacteria on the surgeon's skin.
3. The surgical site is cleaned with povidone iodine and spirit.
4. Entire body is covered with sterile drapes except the surgical site for incision.
5. Surgical procedure is carried out.

Fig. 1.1: Preoperative patient waiting in the premedication room

Fig. 1.2: Postoperative patient recovering in the postoperative ward

6. Patient is shifted to postoperative ward for monitoring haemodynamic parameters for a few hours to days depending upon the severity of the situation. A few examples are given below.
   - Patient who undergoes lymph node biopsy or hernia surgery can be discharged on the same day evening—day care surgery.
   - Laparoscopic surgery, e.g. lap cholecystectomy, patient can be discharged within 1–2 days.
   - Open heart surgeries needs to be monitored for 3–5 days in the postoperative ward.
7. Once haemodynamic stability is achieved as in major surgical procedures, he is shifted to the ward.

In the Ward

Till discharge, the wound is examined for any wound infection, or a careful search is carried out for any postoperative complications, e.g. patient develops fever on the 2nd postoperative day following partial glossectomy done for carcinoma tongue. Most probable reason being respiratory infection which may be atelectasis (collapse) or a pneumonia. Another example: Patient has developed pain in the leg and edema of the leg on the 4th postoperative day. It may be deep venous thrombosis. Many such examples can be given.

Discharge

When patient recovers completely with or without complications, when surgeon feels he is fit for discharge, he is discharged with advice tailored to the patient depending upon the type of surgery, occupation of the patient, etc. For example, a day care surgery like hernia the patient may be discharged on the same day but he would be advised not to do heavy work for a month or so. A patient who develops deep vein thrombosis, needs to take anticoagulants for at least 6 months in the postoperative period.

Follow up

Generally, the patient is asked to come for follow up once, twice or more depending upon the case. You will understand this better after you study various diseases.