Vocational Higher Secondary Education (VHSE)

Second Year

BIOMEDICAL EQUIPMENT TECHNOLOGY

Reference Book

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Department of Education

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Foreword

Dear Learners,

This book is intended to serve as a ready reference for learners of vocational higher secondary schools. It offers suggested guidelines for the transaction of the concepts highlighted in the course content. It is expected that the learners achieve significant learning outcomes at the end of the course as envisaged in the curriculum if it is followed properly.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of this reference book has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. P. A. Fathima
Director
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ABOUT THE COURSE

A variety of electrical and electronic equipment are used in hospitals for various diagnostic and therapeutic purposes; including operation theatre and also used for anesthesia and surgical purposes. Modern medicine is emerging in new trend in equipment technology. The success of the procedures and safety of patient depends largely on the reliability, precision sensitivity and trouble free performance of these equipment. It is also necessary that Biomedical equipment used in hospitals and diagonostic centres should be standardized by callibrating in time. For this, we need qualified and skilled technicians. But skilled hands are very less in this sector. Due to the lack of these technicians Biomedical equipments remain in un operational condition without adequate maintenance support especially in govt sector. So this course can fill this lacunae providing trained manpower in almost all branches of modern medicine like Cardiology, Nuerology,Physical Medicine, Medical imaging, CSSD,Dialysis room,Manifold, etc.. They can get vertical mobility in all these disciplines in medical field. This will lead to better service to the mankind aiming at better healthcare management.

BET COURSE - MAJOR SKILLS

This course offers therapeutic/ analytical and surgical equipment in module 3 and medical imaging equipment in module 4.

- Understand Production, properties and applications of X-rays, absorption of X-rays, unit of X-ray the principle of radiography,
- Identify the block diagram of X-ray machine , types of X-ray machine, unit of X rays- Mobile, stationary, OPG, C arm, mammography, digital X-ray. X-ray film- Construction- processing and digital processing. AERB regulations and general safety in radiography, Effect of X-ray in human body.
- Familiarize and identify operation theater equipment like OT lights, OTtables, Anesthesia equipment, Elecrto surgical unit, and other OT equipments
- Aims and objectives of CSSD, workflow in CSSD, concept of sterilization - definition and importance of sterilization, classification and methods of sterilization, equipment used for sterilization and their uses, autoclave , hot air oven. Equipment safety and sterilization controls (chemical and biological controls), and introduction to liquid oxygen supply.
- Identify and understand Microscopy - different types of microscopes, working principle, parts, magnification, adjustments, maintenance and uses of a compound microscope
- Identify and understand photoelectric colorimeter - working principle, parts, block diagram, procedure, maintenance and applications, introduction to glucometers.

- Identify and understand - PHmeter- working principle, parts, block diagram, procedure, maintenance and applications, Clinical relevance of blood PH,
- Importance of general safety in hospitals, the effects of electricity on human body, electric shock hazards and precautions to avoid shock, IEC document and safety codes of biomedical equipment, grounding in Biomedical Equipment, familiarize Rules and Ethics in medical field.
- Familiarize and identify - Centrifuge- parts, working, maintenance of table top centrifuge, Fundamentals of Eletrolyte analyser, Blood gas analyser, incubator and waterbath , Familiarise Automatic Hemoanalysers and blood cell counters, General safety, equipment safety and Quality Control in Medical laboratories, name and uses of Blood bank equipments-Blood bank refrigerators, Blod bank centrifuges, cryo centrifuge,cry bath, deep freezers,Apheresis machines, donor couch, blood bag sealer, platelet agitator, blood shaker.
- Familiarize and identify - concept of central medical gas supply system, basic components, manifold, suction apparatus - parts, working and uses, introduction to pendant for gas supply, safety and precautions in manifold and pipeline supply.
- Familiarize dialysis - Importance of dialysis, Types of dialysis - peritoneal dialysis and hemo dialysis, Hemodialysis - fundamentals and applications

" Enlist therapeutic equipments- Radiotherapy , physiotherapy ,phototherapy, magneto therapy equipment. Radiotherapy Equipment -
Physiotherapy equipment - Short wave diathermy, microwave diathermy, ultrasound diathermy, nerve and muscle stimulators, TENS, IFT, IR lamps, CPRM,

- Familiarize biomedical waste management - definition and classification of biomedical waste., steps in waste management, segregation, collection, storage, transportation, disposal - equipment used, autoclave, incinerator, safety aspects regarding biomedical waste.
- Enlist Fiber optic equipment in medicine and equipment in an ICU,
- Familiarize Enginering services, civil engineering, mechanical work shop, Electrical.
- Understand ultra sound physics, principle of oscillation, circuit diagram- working of crystal oscillator, fundamentals of ultra sonography, medical applications of ultra sonography
- Familiarize fundamentals of CT scanning, Fundamentals of MRI scanning. Familiarization of modern imaging techniques- names only, Applications of PET, SPECT, gamma camera.

SYLLABUS

MODULE 3

Surgical/Analytical and Therapeutic Equipment

UNIT 1: OPERATION THEATRE EQUIPMENT

Basic fundamentals of operation theatre, List of OT equipment and its applications (OT tables, OT lights, Anesthesia machines, Anesthesia ventilators, multi para monitor, ESU, central suction, heart lung machine - names and uses only), Characteristics, classification, types of OT table (mechanical, pneumatic and electrical) and light (Lux, voltage and wattage), fundamentals of Anesthesia, parts of anesthesia machine and applications, principle of surgical diathermy, different electrodes used in surgical diathermy, different modes of operation in surgical diathermy (electrotomy, coagulation, fulguration, desiccation), block diagram and description of ESU, applications of ESU, safety in OT - general guidelines, equipment safety - ESU and anesthesia machines, concept of modular OT.

UNIT 2 : CENTRAL STERILE SUPPLY DEPARTMENT (CSSD)

Aims and objectives of CSSD, workflow in CSSD, concept of sterilization - defini9sion and importance of sterilization, classification and methods of sterilization, equipment used for sterilization and their uses, autoclave - working principle - parts, procedure, maintenance and uses, hot air oven - parts, procedure, maintenance and uses. Equipment safety and sterilization controls (chemical and biological controls), introduction to liquid oxygen supply.

UNIT 3 : CENTRAL MEDICAL GAS DISTRIBUTION SYSTEM

Introduction to concept of central medical gas supply system, basic components, manifold, suction apparatus - parts, working and uses, introduction to pendant for gas supply, safety and precautions in manifold and pipeline supply.

UNIT4 : LABORATORY AND BLOOD BANK INSTRUMENTS

Microscopy - introduction , different types of microscopes, working principle, parts, magnification, adjustments, maintenance and uses of a compound microscope, photoelectric colorimeter - working principle, parts, block diagram, procedure, maintenance and applications, introduction to glucometers. PHmeter- working principle, parts, block diagram, procedure, maintenance and applications, Clinical relevance of blood PH, Centrifuge- parts, working, maintenance of table top centrifuge, Fundamentals of Eletrolyte analyser, Blood gas analyser, incubator and waterbath , Familiarise Automatic Hemoanalysers and blood cell counters, General safety, equipment safety and Quality Control in Medical laboratories, name and uses of Blood bank equipments-Blood bank refrigerators, Blod bank centrifuges, cryo centrifuge,cry bath, deep freezers,Apheresis machines, donor couch, blood bag sealer, platelet agitator, blood shaker.

UNIT5: DIALYSIS EQUIPMENT

Introduction to dialysis - Importance of dialysis, Types of dialysis - peritoneal dialysis and hemo dialysis, Hemodialysis - fundamentals and applications

UNIT 6: THERAPEUTIC EQUIPMENTS

Introduction to types of therapeutic equipments- Radiotherapy , physiotherapy ,phototherapy, magneto therapy equipment. Radiotherapy Equipment -

Physiotherapy equipment - Short wave diathermy, microwave diathermy, ultrasound diathermy, nerve and muscle stimulators, TENS, IFT, IR lamps, CPRM, (names and uses only is required)

UNIT 7: BIOMEDICAL WASTE MANAGEMENT

Introduction to biomedical waste management - definition and classification of biomedical waste., steps in waste management, segregation, collection, storage, transportation, disposal - equipment used, autoclave, incinerator, safety aspects regarding biomedical waste.

UNIT 8: AUDIOMETRY

Anatomy of ear and mechanism of hearing. Types of audiometers - Pure tone audiometer and speech audiometer, the parts and operation of pure tone audiometer, the types and uses of hearing aids.

UNIT 9: FIBER OPTICS IN MEDICINE, (List of equipment and its uses), laser and its uses, Engineering service - civil engineering, medical, electrical.

Fiber optics in medicine(List out equipment and its uses) ,

civil engineering - water supply, mechanical work shop, air conditioning, electrical.

MODULE 4

Medical Imaging

UNIT1: RADIOGRAPHY

Production, properties and applications of X-rays, absorption of X-rays, unit of X-ray the principle of radiography, block diagram of X-ray machine , types of X-ray machine, unit of X rays- Mobile, stationary, OPG, C arm, mammography, digital X-ray. X-ray film- Construction- processing and digital processing. AERB regulations and general safety in radiography, Effect of X-ray in human body.

UNIT2 : ULTRASONOGRAPHY

To understand ultra sound physics, principle of oscillation, circuit diagram- working of crystal oscillator, fundamentals of ultra sonography, medical applications of ultra sonography

Unit 3 - MODERN EQUIPMENT IN MEDICAL IMAGING

Fundamentals of CT scanning, Fundamentals of MRI scanning. Familiarization of modern imaging techniques- names only, Applications of PET, SPECT, gamma camera.

Unit 4 - PATIENT SAFETY

Importance of general safety in hospitals, the effects of electricity on human body, electric shock hazards and precautions to avoid shock, IEC document and safety codes of biomedical equipment, grounding in Biomedical Equipment, familiarize Rules and Ethics in medical field.

PART B

OVERVIEW OF MODULE 3

SURGICAL/ANALYTICAL &THERAPEUTIC EQUIPMENT

This module includes different surgical , analytical and therapeutic equipment used in medical field. As a beginner in biomedical equipment technology, a learner can be exposed to all these equipment. In unit 1 , general surgical equipment like OT table, OT lights, surgical diathermy, anesthesia machines, anesthesia ventilators , and electro surgical unit are included .

Importance of sterilization in a hospital environment , Types of sterilization ,Equipment its applications, sterile materials and its supply is given in unit 2.

Central medical gas distribution system is given as third unit, It includes types of medical gases, storage and supply through pipeline system. Suction apparatus its working and application is also included in this unit.

Unit 4 include laboratory and blood bank instruments. Here in this module we cover Microscopy, Maintenance, parts, uses and working of Photo electric colorimeter, PH meter, Basic idea of Electrolyte analyzer, blood gas analyser, incubator and waterbath. Biochemical and hematology auto analyzers are also included. Introduction to blood cell counters and blood bank equipment is also given.

Hemodialysis equipment, radiotherapy equipment, physiotherapy equipment, are introduced. An important department in medical field included is Biomedical waste management. As a person working in a hospital environment one should understand the importance of Biomedical waste management. Fundamentals of collection, segregation, processing only is given.

An introduction to fiberoptic instruments,equipment in an ICU, civil, mechanical and electrical departments is given for familiarization for the learner. Hospital computer applications and and importance of hospital information system is also included.

Unit 1

Operation Theatre Equipment

Introduction

Operation theatre is a space for surgical procedures in a hospital. It consists of a preparatory area, pre surgical area and a procedure area. The procedure area is an absolutely sterile area for during the surgery. All surgical equipment is kept in this area.OT tables, OT lights, anesthesia cart, ESU, all other surgical tools are kept in this area. Details of principle, parts, working and applications of ESU is also included in the syllabus.

Learning Outcome

Upon completion of unit, the learner will be able to:-

- **3.1.1** Basic fundamentals of operation theatre.
- **3.1.2** List of OT equipments and its applications.
- **3.1.3** Familiarise OT table and light.
- **3.1.4** Familiarise fundamentals of anesthesia, parts of anesthesia machine.
- **3.1.5** Understand the principles of diathermy.
- **3.1.6** Familiarise different electrodes used in surgical diathermy.
- **3.1.7** Familiarise different modes of operation in surgical diathermy.
- **3.1.8** Identify the block diagram and description of ESU.
- **3.1.9** Identify the applications of ESU.
- **3.1.10** Identify the general safety aspects and equipment safety in OT.

Basic fundamentals of operation theatre

An operating theater is a facility within a hospital where surgical operations are carried out in a sterile environment. Operating rooms are spacious, easy to clean, and well-lighted. Operating rooms consist of overhead surgical lights, operation table and may have equipment, viewing screens and monitors. Rooms are supplied with wall suction, oxygen, and possibly other anesthetic gases. There is storage space for common surgical supplies.

Operation theatres are designed as per the requirements of the hospital like number of beds, types of surgical procedures, number of surgeons, number of surgery per day etc.

The operation theatre have mainly four zones - protective zone, clean zone, sterile zone and disposal zone.

Protective zone - reception, waiting for patients, changing room, pre- anesthesia room, store room, autoclave room ,control room for electricity.etc.

Clean zone - pre-operating room, recovery room, plaster room, x-ray unit, staff room, anesthesia store

Sterile zone - operating room, scrub room, aesthesia room, instrument trolley area, instant sterilization unit.etc..

Disposal room - disposal corridors, dirty wash up room.

An operation theatre should be supplied with uninterrupted power supply, air conditioning and ventilation. Manifold facilities, service pendant provisions should be made. Fixed service pendent are usually available with oxygen, compressed air and vacuum outlet. High efficiency HEPA filters provide clean and sterile air in operating rooms. Maintenance of OT aseptic standards is very much important to minimize hospital acquired infections..

The significance of location, grouping and size has a role to play in planning OT.A properly staffed , equipped and organized OT along with well framed policies and procedures ,functions with high standards of efficiency.

List of OT equipment and its applications.

1. Operating table
2. Anesthesia machine
3. Anesthesia cart
4. Ventilator
5. Multiparameter monitor
6. Central suction
7. Heart-lung machine
8. Defibrillator
9. ESU
10. Pulse oximeter

Applications OT equipment

1. The anesthesia machine - Minimize anaesthesia related risk to patient and staff. 2. The anesthesia cart - It contains the medications, equipment, and other supplies that the anesthesiologist may need.
3. Multipara monitor- Records the BP, ECG, heart rate and oxygen saturation
4. The pulse oximeter machine- Measures the amount of oxygen contained in the blood.
5. Automated blood pressure measuring machine- Measures BP automatically.
6. Heart-lung machine takes the temporary control of the heart and lung during the surgery maintaining the circulation of blood and oxygen content of the body

OT table

The operating table is a table on which a patient is placed during a surgical operation.

Stationary operating table system is firmly anchored to the floor. So the additional necessary medical devices can easily be brought to the operating area and positioned.

The advantage of the mobile operating table, on the other hand, is that the position of the table can be changed within the operating room. However, the foot of the table limits the leg space available to the surgical team.

Another special feature of the operating table system is the ability to establish communication with diagnostics systems. (Angiography, MRI and CT etc). This is only possible with stationary columns.

Surgical lights provide lighting in surgical suites to illuminate the surgical site for optimal visualization without shadows during surgery.

Types of lamps include tungsten, quartz, and/or xenon halogens and light-emitting diodes. Advantages of LED is less heat, longer life, better energy efficiency, pure white colour,more colour rendition, improved shadow control.

The Halogen Operation Lights are designed to assists during critical operations where focused source of bright light is required.

Familiarize fundamentals of anesthesia

When anaethesia is given, the patient loses consciousness. The usual method of anaethesia is inhalation anaethesia. The most widely used anesthetic gases are halogenated ethers such as enflurane, halothane, isoflurane, and desflurane coupled with nitrous oxide. During anaethesia, required amount of oxygen is also supplied to the patient. In critical stage it is necessary to support the patient with controlled ventilation also.

Four essential functions are

1. Provides oxygen
2. Mix anesthetic gas with vapours
3. Enable patient ventilation
4. Minimise anaesthesia related risk to patient and staff

Anesthetic Machines

- Parts of the machine:

  Oxygen supply: can either be E- or H-tanks, or compressed air

  Oxygen flow meter and **oxygen flush valve**

  Anesthetic vaporizer: usually either Isoflurane or Sevoflurane

  Breathing circuit – **rebreathing** (patients >7kg) or **non-rebreathing** (patients <7 kg)

  Pop-off valve: keep OPEN unless manually "sighing" for patient

  Pressure manometer: do not go above 20cm while "sighing"

  CO2 absorber/granules

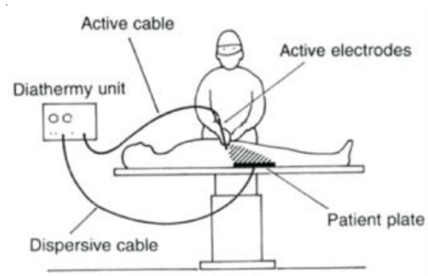
  Reservoir bag: 1L (very small dogs/cats) – 5L (very large dogs)

  Scavenging system: either a charcoal F-air canister (passive) or an outlet pipe into the ceiling or wall of the hospital (active).

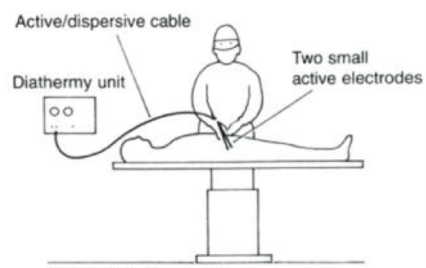
Principles of diathermy

When a high frequency current is applied to tissue, the tissue is heated locally. This property can be used to cut, coagulate, fulgurate and desiccate tissue. The frequency of current used in surgical diathermy is in the range 1-3 MHz

When the intracellular temperature reaches 60 degrees C, instantaneous cell death occurs. If tissue is heated to 60-99 degrees C, tissue desiccation (dehydration) occurs. If the intracellular temperature rapidly reaches 100 degrees C, desiccation and coagulation occur which prevent bleeding.



MONOPOLAR DIATHERMY



BIPOLAR DIATHERMY

Different electrodes used in surgical diathermy

There are two configuration of using surgical diathermy electrode. They are 1. Monopolar configuration 2 Bipolar configuration

In monopolar configuration the patient is attached to an electrode called dispersive electrode, a relatively large metal plate. The surgeon uses a pointed or blade shaped electrode called the "active electrode" to make contact with the tissue.

With "bipolar" instruments the current is applied to the patient using a pair of similarly-sized electrodes.

Different electrodes

a. Lancet electrodes - For cutting application.

b. Needle electrodes - For epilation and desiccation

c. Ball type electrode - For coagulation

d. Loop electrodes - For opening up channels and extirpating growth.

Familiarize different modes of operation in surgical diathermy.

Cutting mode: Electrode touches the tissue. When this HF current passes through the sharp edge of diathermy electrode, there is a high concentration of current at this point and heat is produced. Sufficiently high power current is applied to the tissue.

By increasing current level deeper level cutting take place. Normally continuous RF waveis used for cutting.

Coagulating mode: when the system is operating in "coag mode" the voltage output is usually lower than cutting mode and less power is delivered. Therefore, this generates less heat. Tissue remains grossly unharmed, but cells are destroyed at the point of contact. Smaller vessels are destroyed and sealed, stopping bleeding.

Desiccation: is the process making of extreme dryness. The amount of generated heat is lower than that required for cutting. Needle point electrode is used here. Fulguration mode: In this the superficial tissue is destructed without affecting deep seated tissue. The electrode is held near the tissue without touching it. An electric arc is developed between the electrode and tissue, which heat dries out the tissue.

Haemostasis mode: The simultaneous use of continuous RF wave for cutting and burst of RF wave for coagulation is called haemostasis mode.

Identify the applications of ESU.

Identify the general safety aspects and equipment safety in OT

The general safety aspects of ESU fall into four main categories

1. Burns
2. High frequency current hazard. Electrical interference with the heart muscles (ventricular fibrillation)3.Explosion hazards

1. Burns

A major hazard associated with ESU is burns caused by excess current flow. The burn occurs at the dispersive electrode because of failure to achieve active adequate contact. In a later case, injury occurs at a point where the patient is unintentionally touching a ground object and contact is made over a small area of skin.

The risk of burns also occurs due to the presence of moisture ie the accumulation blood or other fluids around the indifferent electrode can give rise to small, highly conductive area. Burns resulting from small conductive area between the limbs can be prevented by means of dry cloth placed between them.

2. High frequency current hazard

3. Explosion hazards

The spark associated with surgical diathermy can cause a dangerous explosion if explosives such as ether, alcohol and explosives anaethetic gases are not kept away from ESU.

The use of non explosive gases such as nitrous oxides, fluothane or halothane is recommended to prevent such shock hazards. It is also important to kept away,ESU from all flammable gases.

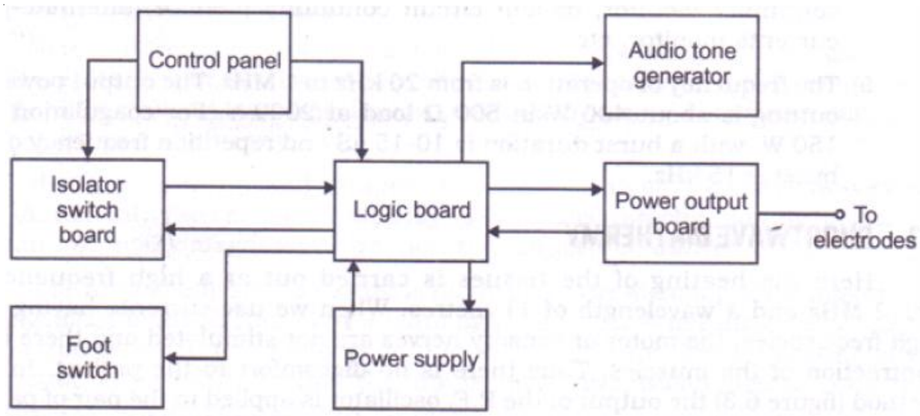


Figure 6.2: Block diagram of electrosurgical diathermy unit

Details of practicals

OT :

1. Operation theatre equipment : Collection of details using internet and preparing charts.
2. Field Visit to operation theatre
3. Preparation of vocational album using operation theatre lights, table, electro surgical unit.

Sample questions

1. List out the different modes of operation in surgical diathermy
2. List out any five equipment used in operation theatre.
3. Draw the block diagram of ESU
4. write the safety precautions to be taken in using ESU.
5. The frequency off AC usually used in ESU is ----------------

Unit: 2

Central Sterile Supply Departments CSSD

Introduction

This unit deals with the processes done in the CSSD , Aims and objectives of CSSD, work flow in a CSSD, Importance of sterilization in a hospital, methods of sterilization, equipments used for sterilization ,their working, parts, and applications.

The central sterile supply department (CSSD) is an important facility of a hospital which ensures a high standard of sterilization and disinfection to minimize hospital acquired infections. CSSD services are responsible for receiving, processing, storing, issue and control of professional supply of instruments, equipments and surgicals.

SYLLABUS

Aims and objectives of CSSD, workflow in CSSD, concept of sterilization - defini9sion and importance of sterilization, classification and methods of sterilization, equipment used for sterilization and their uses, autoclave - working principle - parts, procedure, maintenance and uses, hot air oven - parts, procedure, maintenance and uses. ETO sterilization , Flash sterilizers, Equipment safety and sterilization controls (chemical and biological controls)

LEARNING OUTCOMES

3.2.1 Identify the aims and objectives of CSSD

3.2.2 Familiarise work flow in CSSD.

3.2.3 Identify the definition and importance of sterilization

3.2.4 Classification and methods of sterilization.

3.2.5 Identify the equipment used for sterilization and their uses.

3.2.6 Autoclave- Working principle, parts.

3.2.7 Hot Air Oven - Parts, procedure, uses.

3.2.8 Familiarise general safety aspects and sterilization control.

3.2.9 Idea about liquid oxygen supply

Aims and Objectives of CSSD

- To promote and provide: -Efficient, effective, Economical, Uniform source of Sterile /Non sterile supplies to various users of hospital sub units for patient care.
- Provide valuable assistance to purchasing department in selection of pre-tested goods and to avoid duplication or obsolete instruments.
- Act as an adviser standardizing department for testing efficiency of new products.Supplies sterile equipments to highly specialized units like OTs, ICUs, ICCUs, CTVS, Urology, various wards and emergency units
- To initiate research to improve techniques and quality of sterilization.
- To educate student nurses and ancillary personnel & professionals.
- To organize efficient repair and maintenance of equipments handled by the department.
- To take effective part in hospital infection control committee to curb Hospital Acquired Infections

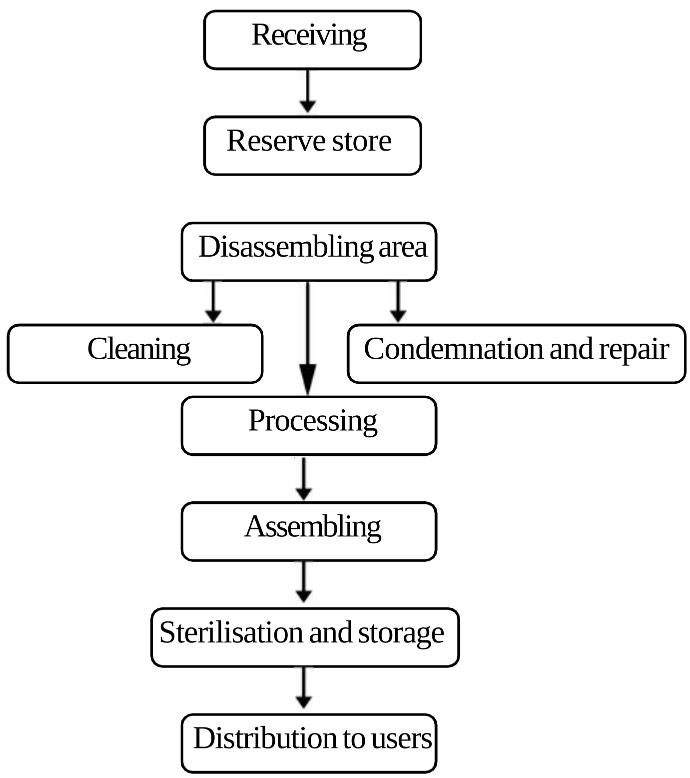
Components of CSSD

A	Administrative office	Dirty area
B	Receiving area Clean up/washing area	
C	Un sterile storage (Syringe, needle, instruments) Glove processing area Work area - sorting, inspecting, packing of various trays	Clean area
D	Sterilization Autoclaving Storage of sterile items	Sterile area

Methods of Sterilization in CSSD

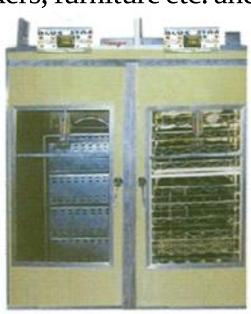
1. Sterilisation - high vacuum,pre-vaccum
2. Hot air sterilization
3. ETO sterilization
4. Chemical sterilization - Gluteraldehyde
5. Gamma sterilization

WORK FLOW IN A CSSD



Equipments in C.S.S.D

- Ultrasonic machine - For cleaning joint instruments, syringes & catheters.
- Washer disinfector - For cleaning & disinfection of instruments.
- Glove processing unit (glove washer, glove powder, glove dryer) - For glove sterilizing and packing
- Drying cabinets -
  * Hot air oven used for drying , washed instruments
- Ethylene oxide sterilization chamber -Sterilization of heat sensitive articles eg. Plastic, rubber goods, biologicals, sensitive instruments.
- Sealing machine - To seal plastic wrapping for gas sterilization
- Autoclaves -For sterilization of various OT loads, linen, trays etc.
- Compressed air controlled pressure gun - Washing and drying of narrow lumen needle, catheter & instruments.
- Boilers - For steam generation
- Incubators -For microbiological testing of ampoules
- Ultraviolet cabinets - For storage of sterile instruments/sets for 72 hours.
- Furniture & fixtures - Sink, cupboards, assembly bench, folding tables, paper bags, markers, furniture etc. and electrical points.

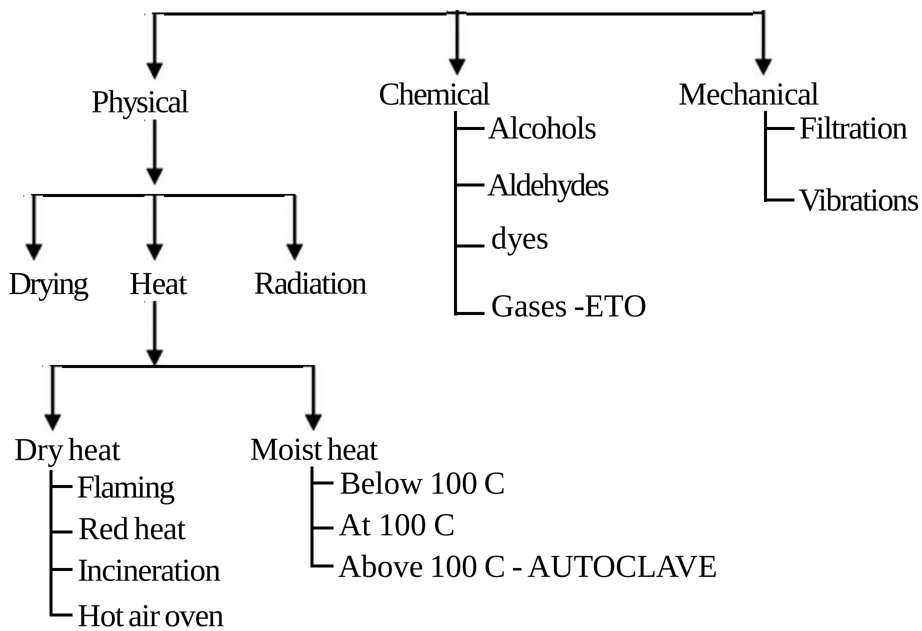



STERILISATION

Sterilization is the removal of all kinds of microbes (bacteria, viruses, & fungi) in a material or on the surface of an object both from vegetative and spore state. Sterilization can be achieved by physical, chemical and mechanical means. Chemicals used as sterilization are called disinfectants.

As microorganisms are seen everywhere it becomes necessary to destroy or remove them because they cause infection. So it is important in a hospital environment to kill all pathogenic as well as contaminants microorganisms. It is also necessary to avoid infecting patients from surgical instruments, dressings, nursing equipments, food materials and drugs. Hence sterilization of very importance in hospitals.

Methods of sterilization



METHODS OF STERILISATION

Heat: Heat is considered to be most reliable method of sterilization of articles that can withstand heat. Heat acts by oxidative effects as well as denaturation and coagulation of proteins. Those articles that cannot withstand high temperatures can still be sterilized at lower temperature by prolonging the duration of exposure.

Moist heat is superior to dry heat in action. Temperature required to kill microbe by dry heat is more than the moist heat.

DRY HEAT:

Red heat: Articles such as bacteriological loops, straight wires, tips of forceps and searing spatulas are sterilized by holding them in Bunsen flame till they become red hot..

Flaming: This is a method of passing the article over a Bunsen flame, but not heating it to redness.

Incineration: This is a method of destroying contaminated material by burning them in incinerator. Articles such as soiled dressings; animal carcasses, pathological material and bedding etc should be subjected to incineration.

Hot air oven: This method was introduced by Louis Pasteur. Articles to be sterilized are exposed to high temperature (160o C) for duration of one hour in an electrically heated oven. Since air is poor conductor of heat, even distribution of heat throughout the chamber is achieved by a fan. The heat is transferred to the article by radiation, conduction and convection. The oven should be fitted with a thermostat control, temperature indicator, meshed shelves and must have adequate insulation. Articles sterilized: Metallic instruments (like forceps, scalpels, scissors), glasswares (such as petri-dishes, pipettes, flasks, all-glass syringes), swabs, oils, grease, petroleum jelly and some pharmaceutical products.

Sterilization process: Articles to be sterilized must be perfectly dry before placing them inside to avoid breakage. Articles must be placed at sufficient distance so as to allow free circulation of air in between. Mouths of flasks, test tubes and both ends of pipettes must be plugged with cotton wool. Articles such as petri dishes and pipettes may be arranged inside metal canisters and then placed. Individual glass articles must be wrapped in kraft paper or aluminum foils. Sterilization cycle: This takes into consideration the time taken for the articles to reach the sterilizing temperature, maintenance of the sterilizing temperature for a defined period (holding time) and the time taken for the articles to cool down. Different temperature-time relations for holding time are 60 minutes at 160o C, 40 minutes at 170o C and 20 minutes at 180o C. Increasing temperature by 10 degrees shortens the sterilizing time by 50 percent. The hot air oven must not be opened until the temperature inside has fallen below 60o C to prevent breakage of glasswares.

Sterilization control: Three methods exist to check the efficacy of sterilization process, namely physical, chemical and biological.

Physical: Temperature chart recorder and thermocouple.

Chemical: Browne's tube No.3 (green spot, color changes from red to green)

Biological: 106 spores of Bacillus subtilis varniger or Clostridium tetani on paper strips are placed inside envelopes and then placed inside the hot air oven.

MOIST HEAT:

Moist heat acts by coagulation and denaturation of proteins.

At temperature below 100 c- Pasteurization , Vaccine bath:, Inspissation:

At 100 c: Boiling: Boiling water (100o C) kills most vegetative bacteria and viruses immediately Steam at 100o C: Instead of keeping the articles in boiling water, they are subjected to free steam at 100o C. Traditionally Arnold's and Koch's steamers were used.

At temperature above 100oC

Autoclave: Sterilization can be effectively achieved at a temperature above 100o C using an autoclave. Water boils at 100o C at atmospheric pressure, but if pressure is raised, the temperature at which the water boils also increases. In an autoclave the water is boiled in a closed chamber. As the pressure rises, the boiling point of water also raises. At a pressure of 15 lbs inside the autoclave, the temperature is said to be 121o C. Exposure of articles to this temperature for 15 minutes sterilizes them. Substances like oil cannot be sterilized since moist heat doesn't have such penetrating capacity.

Advantages of steam: It has more penetrative power than dry air, it moistens the spores (moisture is essential for coagulation of proteins), condensation of steam on cooler surface releases latent heat, condensation of steam draws in fresh steam.

Operation Of Autoclave: A simple autoclave has vertical or horizontal cylindrical body with a heating element, a perforated try to keep the articles, a lid that can be fastened by screw clamps, a pressure gauge, a safety valve and a discharge tap. The articles to be sterilized must not be tightly packed. The screw caps and cotton plugs must be loosely fitted. The lid is closed but the discharge tap is kept open and the water is heated. As the water starts boiling, the steam drives air out of the discharge tap. When all the air is displaced and steam start appearing through the discharge tap, the tap is closed. The pressure inside is allowed to rise upto 15 lbs per square inch. At this pressure the articles are held for 15 minutes, after which the heating is stopped and the autoclave is allowed to cool. Once the pressure gauge shows the pressure equal to atmospheric pressure, the discharge tap is opened to let the air in. The lid is then opened and articles removed.

Sterilization control: Physical method includes automatic process control, thermocouple and temperature chart recorder.

Chemical method includes Browne's tube No.1 (black spot) and succinic acid (whose melting point is 121o C) and Bowie Dick tape. Bowie Dick tape is applied to articles being autoclaved. If the process has been satisfactory, dark brown stripes will appear across the tape.

Biological method includes a paper strip containing 106spores of Geobacillusstearothermophilus.

RADIATION:

Two types of radiation are used, ionizing and non-ionizing. Non-ionizing rays are low energy rays with poor penetrative power while ionizing rays are high-energy rays with good penetrative power.

Non-ionizing rays: Rays of wavelength longer than the visible light are non-ionizing. Microbicidal wavelength of UV rays lie in the range of 200-280 nm, with 260 nm being most effective. Microorganisms such as bacteria, viruses, yeast, etc. that are exposed to the effective UV radiation are inactivated within seconds. Since UV rays don't kill spores, they are considered to be of use in surface disinfection. UV rays are employed to disinfect hospital wards, operation theatres, virus laboratories, corridors, etc. Disadvantages of using uv rays include low penetrative power, limited life of the uv bulb, some bacteria have DNA repair enzymes that can overcome damage caused by uv rays, organic matter and dust prevents its reach, rays are harmful to skin and eyes. It doesn't penetrate glass, paper or plastic. Ionizing rays: Ionizing rays are of two types, particulate and electromagnetic rays. Electron beams are particulate in nature while gamma rays are electromagnetic in nature.

FILTRATION:

Filtration separates microbes out.

SONIC AND ULTRASONIC VIBRATIONS:

Sound waves of frequency >20,000 cycle/second kills bacteria and some viruses on exposing for one hour.

CHEMICAL METHODS OF DISINFECTION:

Disinfectants are those chemicals that destroy pathogenic bacteria from inanimate surfaces. Some chemical have very narrow spectrum of activity and some have very wide. Those chemicals that can sterilize are called chemisterilants. Those chemicals that can be safely applied over skin and mucus membranes are called antiseptics.

ALCOHOLS:

Mode of action: Alcohols dehydrate cells, disrupt membranes and cause coagulation of protein. Examples: Ethyl alcohol, isopropyl alcohol and methyl alcohol Application: A 70% aqueous solution is more effective at killing microbes than absolute alcohols. 70% ethyl alcohol (spirit) is used as antiseptic on skin. Isopropyl alcohol is preferred to ethanol. It can also be used to disinfect surfaces. It is used to disinfect clinical thermometers.

ALDEHYDES:

Mode of action: Acts through alkylation of amino-, carboxyl- or hydroxyl group, and probably damages nucleic acids. It kills all microorganisms, including spores. Examples: Formaldehyde, Gluteraldehyde PHENOL: Mode of action: Act by disruption of membranes, precipitation of proteins and inactivation of enzymes. Examples: 5% phenol, 1-5% Cresol, 5% Lysol (a saponified cresol), hexachlorophene, chlorhexidine, chloroxylenol (Dettol)

HALOGENS:

Mode of action: They are oxidizing agents and cause damage by oxidation of essential sulfydryl groups of enzymes. Chlorine reacts with water to form hypochlorous acid, which is microbicidal. Examples: Chlorine compounds (chlorine, bleach, hypochlorite) and iodine compounds (tincture iodine, iodophores) Applications: Tincture of iodine (2% iodine in 70% alcohol) is an antiseptic.

SURFACE ACTIVE AGENTS:

Mode of actions: They have the property of concentrating at interfaces between lipid containing membrane of bacterial cell and surrounding aqueous medium. These compounds have long chain hydrocarbons that are fat soluble and charged ions that are water-soluble. Since they contain both of these, they concentrate on the surface of membranes. They disrupt membrane resulting in leakage of cell constituents. Examples: These are soaps or detergents.

HYDROGEN PEROXIDE:

Mode of action: It acts on the microorganisms through its release of nascent oxygen. Hydrogen peroxide produces hydroxyl-free radical that damages proteins and DNA. Application: It is used at 6% concentration to decontaminate the instruments, equipments such as ventilators. Disadvantages: Decomposes in light, broken down by catalase, proteinaceous organic matter drastically reduces its activity.

ETHYLENE OXIDE (ETO):

Mode of action: It is an alkylating agent. It acts by alkylating sulfydryl-, amino-, carboxyl- and hydroxyl- groups. Properties: It is a cyclic molecule, which is a colorless liquid at room temperature. It has a sweet ethereal odor, readily polymerizes and is flammable. Application: It is a highly effective chemisterilant, capable of killing spores rapidly. Since it is highly flammable, it is usually combined with CO2 (10% CO2+ 90% EO) or dichlorodifluoromethane. It requires presence of humidity. It has good penetration and is well absorbed by porous material. It is used to sterilize heat labile articles such as bedding, textiles, rubber, plastics, syringes, disposable petri dishes, complex apparatus like heart-lung machine, respiratory and dental equipments. Efficiency testing is done using Bacillus subtilis varniger. Disadvantages: It is highly toxic, irritating to eyes, skin, highly flammable, mutagenic and carcinogenic.

SONIC AND ULTRASONIC VIBRATIONS

Microwaves are not particularly antimicrobial in themselves, rather the killing effect of microwaves are largely due to the heat that they generate. High frequency sound waves disrupt cells. They are used to clean and disinfect instruments as well as to reduce microbial load. This method is not reliable since many viruses and phages are not affected by these waves.

Practical Activities

1. Working of simple autoclave - laboratory practical.
2. Working of hot air oven - Lab practical
3. Preparation of report on work flow in CSSD.
4. Visit to CSSD in a hospital and preparation of visit report.

Unit -3

Central Medical Gas Distribution System

Introduction

In modern medicine supply of medical gases is of significant role. In olden days gases were supplied in gas cylinders and the attenders used to roll it to the casualty or operation theatres. Now central pipeline system is available in pipeline system in all modern hospitals.

Learning objectives

3.3.1 An idea of medical gas distribution system

3.3.2 Identify the components of medical gas distribution system

3.3.3 Familiarise manifold.

3.3.4 Identify the parts, working and use of suction apparatus.

3.3.5 Discuss safety in manifold and distribution of medical gas.

I. Central Gas System

Certain gases like Oxygen, Nitrous Oxide and compressed air have achieved a commendable position in the modem treatment procedure. They have played a very significant role in saving a vast number of patients from the hands of death. They are now became an unavoidable part of almost all the minor as well as major surgical operations. A surgeon cannot imagine himself doing a surgery without these gases being kept ready for supply in the theatre. Hence the gas supply system had now became an indispensable part of any hospital.

The most convenient method of gas supply in hospital system is through pipe line from a central storage. Hence this system is called centralised gas supply system or pipeline system. The main part of the component system is a manifold from where the gases are supplied to different destinations. Manifold is the place where the gas cylinders and adjusting and monitoring panels are situated.

The gases generally supplied through pipe line system are:

(i) Oxygen (O2)

(ii) Nitrous Oxide (N2O)

(iii) Compressed Air and

(iv) Vacuum

II. Supply of Oxygen

Hospital Oxygen supply is mainly done using different types of cylinders having a general colour code as "Black body with white neck". There are mainly three types: Bulk Type, Service type or A type and Boyle's type E type.

1. Bulk Type

This is meant for the central pipeline connection. Each cylinder has a capacity of 6800 litters at 140 kg/cm2 pressure. They are provided with "Bull Nose" fittings for connecting with the central line.

2. Service Type or A Type

This type is mainly used as a portable cylinder. They are having a capacity of 1500 litters at 140kg/cm2 pressure. Oxygen is given to the patient through, flow meter. It has also got "Bullnose" fittings. This is used in I.C.U s and wards for shifting the patients.

3. Boyle's Type or E Type

This is designed for connecting with Boyle's machine. It is having "Pin Index" connection for proper attachment with the machine. It is having a capacity of 750 litters at 140 kg/cm2 pressure

III. Supply of Nitrous Oxide (N2O)

Nitrous oxide is supplied in two different types with usual colour code as French blue. Nitrous oxide is a very good anesthetic agent. It is used in hospitals for maintaining the anesthesia during an operation. The two important types of cylinders used for the supply of Nitrous Oxide are: Bulk type and E type.

Bulk Type

This is used in the manifold for the central line supply. Each cylinder has a capacity of 16380 litters at 50 kg/cm2 pressure. They are having four pipeline connections. No service type cylinders are used in the supply of Nitrous Oxide because Nitrous Oxide is not required in I.C.U s and wards.

Boyle's Type or E Type

This is designed for connecting with the Boyle's apparatus. It is also having "pin index" for making proper connection.

For distinguishing from E type Oxygen, Nitrous Oxide having different patterns of knoch are used for connecting

IV. Supply of Compressed Air

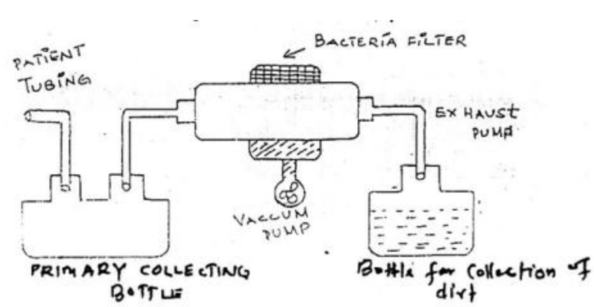
In a hospital system compressed air is also given through pipe line system. For this the atmospheric air is compressed to 60 lb/cm2 and fed to the pipeline for supplying towards I.C.Us. and operation theatres. Atmospheric air is taken into a chamber through air filter. Air in the chamber is compressed with a piston. The to and fro movement of the piston is achieved by means of an externally operated motor. Due to compression, air becomes a high pressure, high temperature gas. Hence it should be passed through cooling coils. For dissipating the heat produced by the frictional movement of the piston, water cooling system is also provided. This compressed air is then collected in a reservoir from where it is allowed to pass through a dryer to make it perfectly dry at the user's end. A second stage regulator is provided to maintain the pressure at 60 lb/cm2 after the dryer stage. At the user's end a grey socket is provided over the self sealing valve as a colour code for compressed air. Compressed air is mainly used in ventilators employed in I.C.Us.

V. Supply of Vacuum - Suction Apparatus

In large hospitals having a lot of operating rooms and I.C.Cs centrised suction system is the best arrangement for providing suction. In this system suction or vacuum is created at the central station and is supplied to the user's end through pipe lines having self-sealing valves. A very big reservoir will be placed in the central station. By means of compression motor air is sucked out from the reservoir and vacuum is created in the reservoir. Other pipe lines provided for the supply of suction are connected to the reservoir. In order to prevent the sucked thing from entering the reservoir a suction apparatus is provided at the user's end. One black cover provided over the self -sealing valve the colour code for suction

Suction Apparatus

Suction apparatus is an instrument used to suck body fluids and semi liquid materials from a patient. It consists of bacteria filter, vacuum pump, bottle for collecting fluid and a regulator. Figure shows the constructional details of a suction apparatus.



A medical suction machine has a nonporous trap or bacteria filter to collect the dirt or micro organisms present in the body fluids. Vacuum pump is used to create necessary vacuum for suction. By using tubing the fluids are sucked and primarily collected in a bottle, from there it is drawn to the bacteria filter or trap. This trap is connected in between the patient and vacuum inlet there for air is drawn in to the piping system. An exhaust is provided on the filter to remove the dirt collected in the trap.

A particular type of suction apparatus is used in the supply of vacuum, to prevent the sucked air entering the reservoir at the users end. It also consists of a bacteria filter a regulator and a collecting bottle.

Manifold

Manifold is the heart of the centralized hospital gas supply system. It is the place where the cylinders of various gases to be supplied are stored. The central reservoir for creating vacuum is also situated in the manifold. The various controls and monitoring panels are also situated in the manifold. The following figure shows the block diagram of the manifold gamy used in pipe line system in hospitals.

Manifold Control Panel

In medical gas pipe line system there are three types of panel controls being used:

1. Four cylinder layer.
2. Eight cylinder layer.
3. Sixteen cylinder layer.

The mechanism of all these systems are identical but the controls should have some changes according to the varying capacities. The control panel is designed to deliver a continuous supply of gas to the pipe line system at a standard pressure of 60 lb/cm2. It is having three main pressure gauges and three pressure regulators. The cylinder line called banks are connected to the second stage regulator through a first stage regulator. There are pressure gauges before the first line to show the condition of that cylinder line. The first stage regulator is used to feed the cylinder line through the second stage regulator. By adjusting this we can set the line which should run first. The second stage regulator is presetted to a value by means of its control screw adjustment. Normally it should be kept at 60 lb/cm2. It is called the "line pressure". The line which is going is called the "running line" and the other line is called the "reserve line". With proper adjustment of the first stage regulators, the reserve line will take over the charge immediately after the finishing of the running line.

Indicators are provided to inform the operator which line is empty. Then he can change those cylinders and charge it as reserved line.

Maintenance of the Manifold

There are two red light indicators on the monitoring panel which will glow when a corresponding tank becomes empty.

1. Release the control lever of the first stage regulator of the empty line.
2. Close all the cylinders in that tank.
3. Uncouple and remove all the empty cylinders.
4. Replace them with filled cylinders. Care should be taken to release a puff of gas from each cylinder to dislodge any dust or grit that may be present in the valve outlet.
5. Open all the cylinder walls. Red signal should now be off.
6. Adjust the control lever of the first stage to make that tank as reserve. This is done by releasing both tanks and then charge the new one over the light running than the first.
7. Check all the connection points with soap solution for gas-tight.

Routine Service.

1. The apparatus should be clean.
2. Rubber, Nylon and other such type of washers should be changed within a period of three months.
3. Periodical servicing should be done in every six months.

VII. Precautions.

1. The couplers should be clean.
2. Test for leakage with soap solution only.
3. Smoking is forbidden in the manifold
4. Always open the cylinder valves slowly.

PRACTICALS

1. Hospital visit and report preparation of central medical gas distribution system.

List preparation of colour coding in various gases used in a hospital.

VIII. TE Questions

1. Central gas supply system is used to distribute different hospital gases. List out the different hospital gases and also mention where it is used.
2. In a hospital system, manifold is an essential part. Define manifold
3. Sujjest an apparatus used for removing liquid or semi solid substance from human body and explain briefly with the help of necessary diagram
4. General colour code of Oxygen cylinder is ______
5. General colour code of Nitrous Oxide cylinder is ______
6. Grey socket is provided over the self sealing value as a colour code for _______
7. Black cover provided over the self sealing value is the colour code for _____

Unit : 4

Laboratory and Blood Bank Instruments

SYLLABUS

Microscopy - introduction, different types of microscopes, working principle, parts, magnification, adjustments, maintenance and uses of a compound microscope, photoelectric colorimeter - working principle, parts, block diagram, procedure, maintenance and applications, introduction to gluco meters. PH meter- working principle, parts, block diagram, procedure, maintenance and applications, Clinical relevance of blood PH, Centrifuge- parts, working, maintenance of table top centrifuge, Fundamentals of Eletrolyte analyzer, Blood gas analyzer, incubator and water bath , Familiarise Automatic Hemoanalysers and blood cell counters, General safety, equipment safety and Quality Control in Medical laboratories, name and uses of Blood bank equipments-Blood bank refrigerators, Blood bank centrifuges, cryo centrifuge, cry bath, deep freezers, Aphaeresis machines, donor couch, blood bag sealer, platelet agitator, blood shaker.

LEARNING OUTCOMES

3.4.1 Identify the different types of microscope.

3.4.2 Understand the working principle, parts, magnification adjustments, care and uses of a compound microscope.

3.4.3 Understand the working principle, parts, block diagram, procedure and applications of a photoelectric colorimeter.

3.4.4 Familiarise semi and fully auto analyser

3.4.5 Understand the principle, procedure, block diagram and working of pH meter.

3.4.6 Understand the clinical relevance of pH of blood.

3.4.7 Familiarise the parts and working of table top centrifuge.

3.4.8 Naming and uses of electrolyte.

3.4.9 Naming and uses of haemo analysers and blood cell counters.

3.4.10 Familiarise safety and quality control aspects in a laboratory.

3.4.11 Naming and uses of blood bank equipment.

Microscopy

Microscopy is the technical field of using microscopes to view objects that cannot be seen with the naked eye (objects that are not within the resolution range of the normal eye). There are three well-known branches of microscopy: optical, electron, and scanning probe microscopy.

Different types of microscopes

1. Optical Microscopes:

These microscopes use visible light to make an image. The light is refracted with optical lenses. The first microscopes that were invented belong to this category. The price of optical microscopes varies from very cheap to nearly unaffordable. Optical microscopes can be further subdivided into several categories:

Compound Microscope: These microscopes are composed of two lens systems, an objective and an ocular (eye piece). The maximum useful magnification of a compound microscope is about 1000x.

Stereo Microscope (dissecting microscope): These microscopes magnify up to about maximum 100x and supply a 3-dimensional view of the specimen. They are useful for observing opaque objects.

Confocal Laser scanning microscope: Unlike compound and stereo microscopes, these devices are reserved for research organizations. They are able to scan a sample also in depth. A computer is then able to assemble the data to make a 3D image.

2. Electron Microscopes

Electron microscopes are the most advanced microscopes used in modern science. The electron microscopes essentially function on the principle of a beam of electrons that strikes any objects that comes to its path to magnify it. Electron microscopes are designed specifically for studying cells and small particles of matter, as wells as large objects.

3. Scanning Probe Microscopes:

Scanning Probe Microscope helps visualize individual atoms. The image of the atom is computer-generated, however. It provides the researchers an imaging tool for the future where a small tip measures the surface structure of the sample. These specialized microscopes provide high image magnification to observe three dimensional specimens. If an atom projects out of the surface, then a higher electrical current flows through the tip. The amount of current that flows is proportional to the height of the structure. A computer then assembles the position data of the tip. An enhanced

3D image is generated.

Compound microscope.

Compound microscope is an optical instrument for forming magnified images of small objects, consisting of an objective lens with a very short focal length and an eyepiece with a longer focal length, both lenses mounted in the same tube.

Working Principle

The most commonly used microscope for general purposes is the standard compound microscope. It magnifies the size of the object by a complex system of lens arrangement.

It has a series of two lenses; (i) the objective lens close to the object to be observed and (ii) the ocular lens or eyepiece, through which the image is viewed by eye. Light from a light source (mirror or electric lamp) passes through a thin transparent object (Figure 4.4).

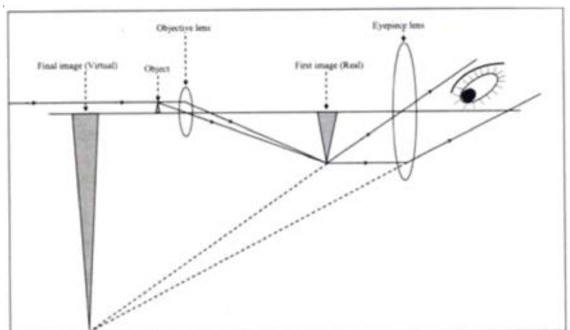


Figure 4.4: Ray diagram of a compound microscope

The objective lens produces a magnified 'real image' first image) of the object. This image is again magnified by the ocular lens (eyepiece) to obtain a magnified 'virtual image' (final image), which can be seen by eye through the eyepiece. As light passes directly from the source to the eye through the two lenses, the field of vision is brightly illuminated. That is why; it is a bright-field microscope.

Compound Microscope Parts

A high power or compound microscope achieves higher levels of magnification than a stereo or low power microscope. It is used to view smaller specimens such as cell structures which cannot be seen at lower levels of magnification.

Essentially, a compound microscope consists of structural and optical components. These key microscope parts are illustrated and explained below.

STRUCTURAL COMPONENTS

The three basic, structural components of a compound microscope are the head, base and arm.

Head/Body houses the optical parts in the upper part of the microscope

Base of the microscope supports the microscope and houses the illuminator

Arm connects to the base and supports the microscope head. It is also used to carry the microscope.

When carrying a compound microscope always take care to lift it by both the arm and base, simultaneously.

Parts of a Compound Microscope:

The parts of a compound microscope are of two categories as given below:

(i) Mechanical Parts: Eyepiece Tube, Nosepiece, Coarse and Fine Focus knobs, Stage, Stage Clips and Condenser Focus Knob.

(ii) OPTICAL parts: Eyepiece Lenses, Objective Lenses, light source, condenser and Iris Diaphragm

Eyepiece or Ocular is what you look through at the top of the microscope. Typically, standard eyepieces have a magnifying power of 10x. Optional eyepieces of varying powers are available, typically from 5x-30x.

Eyepiece Tube holds the eyepieces in place above the objective lens.

Objective Lenses are the primary optical lenses on a microscope. They range from 4x-100x and typically, include, three, four or five on lens on most microscopes. Objectives can be forward or rear-facing.

Nosepiece houses the objectives. The objectives are exposed and are mounted on a rotating tower so that different objectives can be conveniently selected. Standard objectives include 4x, 10x, 40x and 100x although different power objectives are available.

Coarse and Fine Focus knobs are used to focus the microscope. Increasingly, they are coaxial knobs - that is to say they are built on the same axis with the fine focus knob on the outside. Coaxial focus knobs are more convenient since the viewer does not have to grope for a different knob.

Stage is where the specimen to be viewed is placed. A mechanical stage is used when working at higher magnifications where delicate movements of the specimen slide are required.

Stage Clips are used when there is no mechanical stage. The viewer is required to move the slide manually to view different sections of the specimen.

Aperture is the hole in the stage through which the base (transmitted) light reaches the stage.

Illuminator is the light source for a microscope, typically located in the base of the microscope. Most light microscopes use low voltage, halogen bulbs with continuous variable lighting control located within the base.

Condenser is used to collect and focus the light from the illuminator on to the specimen. It is located under the stage often in conjunction with an iris diaphragm.

Iris Diaphragm controls the amount of light reaching the specimen. It is located above the condenser and below the stage. Most high quality microscopes include an condenser with an iris diaphragm.

Condenser Focus Knob moves the condenser up or down to control the lighting focus on the specimen.

There are two optical systems in a compound microscope:

Magnification adjustments of a compound microscope.

1. Turn on the illuminator.
2. Place a slide or specimen on the stage with the sample directly above the aperture and, if possible, fasten it to the stage with the stage clips..
3. Ensure the iris diaphragm is completely open, allowing the maximum amount of light to reach the slide and the lenses. Caution: Do not use the iris diaphragm to control the light, it is to control resolution and contrast - use the dimmer instead.
4. Rotate the nosepiece so that the objective lens with the lowest level of magnification is directly above the sample. Reminder: Using lower magnifications first helps to select the part of the specimen of interest and then adjust further.

5. Look through the binocular eyepieces and adjust the iris diaphragm until the amount of light is satisfactory. More light is better than less light, but the comfort of the viewer's eyes should also be taken into account.
6. Turn the coarse adjustment knob until the specimen comes into broad focus. Caution: you should not use the coarse focus with a high magnification objective for fear of the objective making contact with the slide.
7. Turn the fine adjustment knob until the specimen comes into sharp focus.
8. The viewer should then be able rotate the nosepiece to higher settings and bring the sample into more and more detail with a minimal amount of refocusing.

Care and Use of the Microscope

1. Clear space on the bench before getting the microscope from the cabinet
2. Grasp the microscope with two hands - one on the arm and the other under the base
3. When you remove the microscope from the cabinet, do it slowly and carefully
4. Place the microscope directly on the bench, never on top of papers or books
5. Remove the dust cover and store it in the scope cabinet
6. Verify that the rheostat is set for minimum light (1) and the lamp switch is off (O)
7. Plug in the scope, turn on light and adjust the rheostat light to 6
8. Lower the stage (or raise head)
9. Check that the condenser is flush with the stage and the iris Close one eye at a time to compare images. If they differ, adjust the microscope for your eyes as detailed below
10. Once the slide is perfectly focused and the image is centered on low power, use the knurled nosepiece to click the next larger lens into place. DO NOT USE THE COARSE FOCUS KNOB after increasing diaphragm is open
11. Using the knurled nose ring, rotate and click the shortest, red (4X) lens into place
12. Load a slide, being sure it sits flat on the stage, held by the spring clip
13. Use the large, coarse-focus knob only with the lowest (4X) power objective.

14. While looking into the eyepieces, slowly turn the coarse knob, moving lens closer to stage. As soon as you see a hint of color, switch to the small, fine focus knob and focus the object.

15. Magnification. Only use the fine focus knob to focus with a higher power lens.

PRACTICAL DETAILS

COMPOUND MICROSCOPE

Aim

To study parts and operation of a compound Microscope.

The essential parts of compound Microscope are

1. Mechanical parts

2. Optical Parts

Mechanical Parts

The mechanical parts consist of foot, limb, sub-stage, stage and different mechanical adjustments. The foot is triangular or Horse shoe shaped and the microscope rest on it. The limb or the body of the microscope is attached to the foot by means of a hinge joint. The limb carries the body tube at the upper end and the stage and sub-stage at the lower end, the body tube carries the eyepiece at the upper end and the revolving nose piece containing the objectives at the lower end. The body tube can be moved up and down by adjustment screws for the purpose of the focusing. This is usually achieved by rack and pinion arrangement. There are two type of screws, a pair each for coarse adjustment and fine adjustment. The stage is a rigid platform in which the object to be viewed is kept. The stage has a central hole for the passage of light to illumination of the object. Below the stage is the sub-stage which carries the condenser and iris diaphragm. There is also an adjusting knob for lowering and raising the condenser.

Optical part

The optical part consists of magnifying and illuminating parts. The magnifying parts include the objective and eye piece lens. The objective lenses are low power high power and oil immersion objective. The objective is visualised through the eyepiece. Microscope can be monocular or binocular type.

The illuminating parts are the condenser iris diaphragm and mirror. The condenser is a system of lens, which concentrate light form the illuminating source to the object. Iris diaphragm is located just below the condenser. It can be closed to reduce the light or open for more light by control hand provided with the shuttle. The mirror is plain concave mirror and is seen below the condenser. It helps to reflect the light into the sub-stage condenser.

Adjustment of Microscope:

1. Low power

The low power objective is placed in position, so that objective lens comes in a line with the eye piece. The condenser is lowered. The iris diaphragm is half opened and concave mirror is turned towards the light source. Object is kept on the stage looking though the eye-piece, lower the body tube until a clear magnified image of the object is obtained by moving the coarse adjustment. For getting a more clear image the fine adjustment is used.

2. High power

The high power objective is placed in position. The condenser is half raised the iris diaphragm 3/4th opened and concave or plane mirror can be used.

3. Oil Immersion objective.

Oil immersion objective is placed in position. Condenser is fully raised and iris diaphragm is fully opened. Turn the plane mirror to the light source. Place a drop of oil on the slide and bring the body to till the objective lens just touches the oil. Make fine adjustment and focus the object.

Procedure:

1. Place the microscope on stable place having a convenient height to see through the eyepiece with out bending. Place it near the window if day light is used for illumination. A built in lamp or external lamp can be used for illumination.
2. Set the mirror towards the light source to get maximum light intensity
3. Put the slide on the stage in the space provided between the clips.
4. Revolve the nose piece and align designed objective in position. The objective must click into the slot provided.
5. Look through the eye-piece and adjust the iris diaphragm according to objective used.
6. Adjust the coarse and fine adjustment to make the object more clear.

Result:

PH meter

Clinical relevance of blood PH

The term pH means potentials of Hydrogen.

pH is a measure of the hydrogen ion concentration of a solution. Solutions with a high concentration of hydrogen ions have a low pH and solutions with low concentrations of H+ ions have a high pH.

The equation that defines pH is given as follows:

pH=-log [H+] concentration

This is read:

The pH is equal to minus the log of the H+ concentration.

For example is the H+ concentration is very low, let's say about 0.0000001M, and then the pH is

pH= -log [.0000001] which is the same as -log [1 X 10-7]

The term log [1 X 10-7] = -7

- (-7) = 7

We know that pH is a measure of the acidity or alkalinity of a fluid. The pH may range from 0 to 14. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic or alkaline. Pure water has a pH of 7... Blood is normally slightly basic, alkaline, with a pH range of 7.35 to 7.45. To function properly, the body maintains the pH of blood close to 7.40.

An important property of blood is its degree of acidity and alkalinity, and this is referred to as acid-base balance. The acidity or alkalinity of the blood is indicated on the pH scale. The acidity level increases when the level of acidic compounds in the blood rises or when the level of alkaline compounds in the blood falls. Alkalinity levels increases with the reverse process.

Our bodies live and die at the cellular level. The billions of cells in our bodies must maintain alkalinity, in order to function and stay alive. The first line of defense against disease is a proper pH balance. Disease can only grow in an acidic body, which makes a condition favorable for the growth of bacteria, yeast, fungus, mold, viruses, and any other unwanted organisms. Cancer always strikes those with an over-acidic body. So balancing your pH is widely considered to be the single most important thing you can do for your health.

PH meter- working principle, parts, block diagram, procedure,

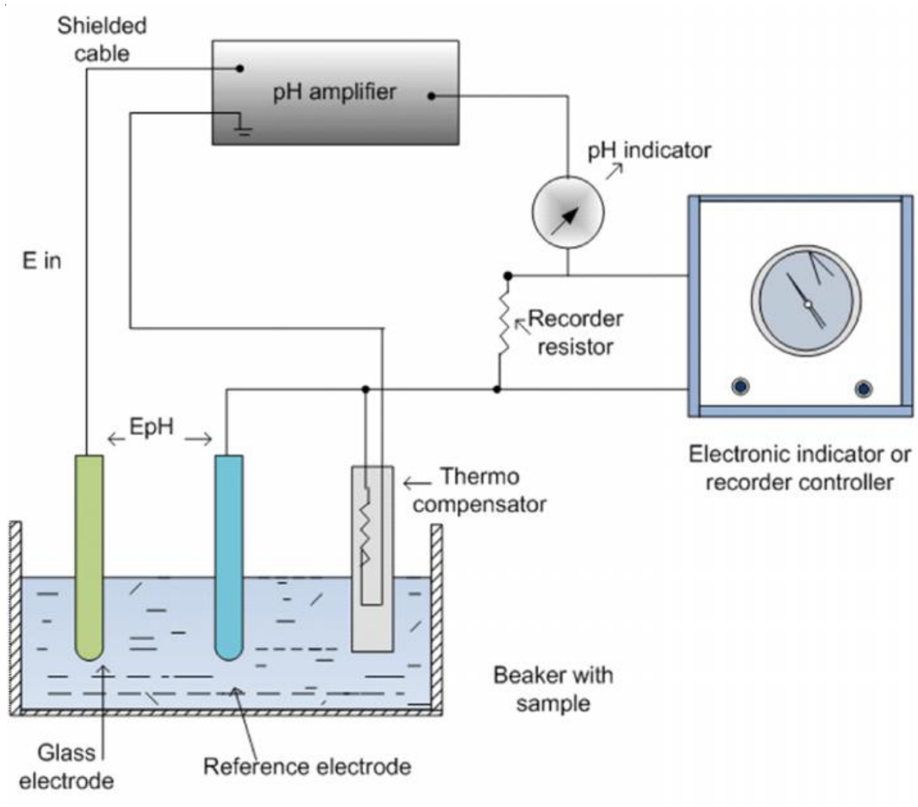
PH meter- working principle

A pH meter provides a value as to how acidic or alkaline a liquid is. It simply measures the voltage between two electrodes and display the result converted into the corresponding pH value.

An acidic solution has far more positively charged hydrogen ions in it than an alkaline one, so it has greater potential to produce an electric current in a certain situation. A pH meter measures the voltage (electrical potential) produced by the solution whose acidity we're interested in, compares it with a reference the voltage and uses the difference in voltage (the "potential difference") between them to find out the pH

They comprise a simple electronic amplifier and a pair of two electrodes or sometimes a combination electrode.

PH meter parts, block diagram



Circuit for electronic pH measurement

A glass electrode is sensitive to hydrogen ions concentration of solution under test. A glass electrode, has a silver-based electrical wire suspended in a solution of potassium chloride, contained inside a thin bulb (or membrane) made from a special glass containing metal salts (typically compounds of sodium and calcium).

The other electrode is called the reference electrode Reference electrode acts as a baseline or reference for the measurement. It has a potassium chloride wire suspended in a solution of potassium chloride. A reference electrode is insensitive to hydrogen ions concentration of solution under test.

Modern pH electrode is a combination electrode, which combines both the glass and reference electrodes into one body.

For pH meters to be accurate, they have to be properly calibrated. They usually need testing and adjusting before you start to use them. So calibrate a pH meter by dipping it into buffers (test solutions of known pH) and adjust the meter accordingly.

Another important consideration is that pH measurements depend on temperature. Some meters have built-in thermometers and automatically correct their own pH measurements as the temperature changes. Alternatively, you can also correct the temperature yourself and allow the pH measurements at a desired temperature.

Procedure of a pH meter.

Rules:

1. The electrode should be in solution when it is "measuring" pH.
2. When out of solution, it should be in stand-by mode.
3. Keep the electrode in solution as much as possible even when not measuring pH.
4. When rinse electrode with water, blot the water off gently using kimwipes - especially around tip of electrode.

   Two point calibration of electrode (in most cases we use pH 4.0 and 7.0 standards). If the solution you are making has a pH over 8.0, use pH 7.0 and 10.0 standards for 2-point calibration. Remove parafilm from the electrode (both bottle and air hole near top). Rinse electrode in water

1. Place electrode in acid pH standard (4.0) - pink solution
2. To turn on pH meter, press standby
3. Press 2pt calibration button (should read 4.00
4. If reads 4.0 press enter - if not, see Dr. Rowland before proceeding

5. The electrode will then measure conductance. Once it stabilizes press enter to accept reading.
6. The electrode will then measure temperature. Again, once stabilizes press enter.
7. Finally press standby to complete measure of 4.0 pH point in calibration

   Rinse electrode with water
8. Place electrode in neutral pH standard (7.0) - yellow solution
9. Repeat steps 2 - 6 above.
10. After temperature reading, the meter will provide a measure of the electrode efficiency. Measures above 90% efficiency are acceptable. If the electrode reading is below this, see Dr. Rowland. If above 90% press enter to accept.
11. Press standby to complete calibration.

Rinse electrode with water and place in 7.0 buffers to store. Be sure to place parafilm over the hole in the electrode and seal the electrode to the buffer container to prevent evaporation of the buffer.

To measure pH of solution: Place electrode in solution you wish to pH. Be sure that it is stirring slowly during measure and pH adjustment. Add acid/base as needed to reach desired pH. When complete, put pH meter in stand-by mode. Remove electrode from solution and rinse thoroughly with water. Blot dry and put back in yellow pH storage buffer. Place parafilm over the hole and around the bottle to minimize evaporation.

Parts block diagram photoelectric colorimeter

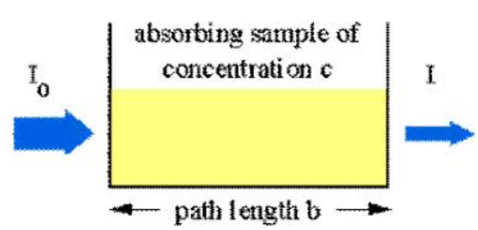
Applications photoelectric colorimeter

Procedure photoelectric colorimeter

Photoelectric colorimeter

Working principle of a photoelectric colorimeter

A colorimeter is a device is most commonly used to determine the concentration of a known solute in a given solution by the application of the Beer-Lambert law, which states that the concentration of a solute is proportional to the absorbance.



The Beer-Lambert law (or Beer's law) state that, when a monochromatic light pass through a solution, absorbance (A) of the solution is directly proportional to the concentration(c) of the solution and path length (b) that solution. Now absorbance A is directly proportional to path length and concentration of that solution.

A ? b c   A = a b c

A - Absorbance of solution

a - Absorbtivity of solution

C - Concentration of solution

b - Path length of solution

Experimental measurements are usually made in terms of transmittance (T), which is defined as:

T = I / I o

where I is the light intensity after it passes through the sample and I o is the initial light intensity. The relation between A and T is:

A = -log T = - log (I / I o).

A colorimeter has following parts:

1. light source (often an ordinary low-voltage filament lamp)
2. filter (the device that selects the desired wavelength)
3. cuvette chamber (the transmitted light passes through this compartment where the glass containing the colored solution are kept)
4. detector (this is a photosensitive element that converts light into electrical signals)
5. Galvanometer (measures electrical signal quantitatively)

The output from a colorimeter may be displayed by an analogue or digital meter and may be shown as transmittance (a linear scale from 0-100%) or as absorbance (a logarithmic from zero to infinity).

Applications photoelectric colorimeter

photoelectric colorimeter is used to determine the concentration of colored compounds in solution. It is used extensively for identification and determination of concentrations of substances that absorb light.

PRACTICAL DETAILS

Procedure:

1. Before switching on the instrument, check the meter for mechanical zero and adjust (only if necessary by the small screw below the meter). Switch on the instrument and check electrical zero.
2. A preset potentiometer is provided with the access from the bottom of the optical plate. If it is necessary to correct the zero, lift the optical place reach our to the present and adjust the zero while looking after the meter.
3. Select the appropriate filter on the filter disc.
4. Place the test tube containing the solvent in the holder. The test tube holder should be placed in position, so that the side pin sets in the slot on the top plate.
5. Press push button and adjust the sensitivity control for 100% transmission reading on the meter. Rotating the coarse control towards you to increase the intensity of the light.
6. Replace the test tube containing solvent with the one containing with standard solution
7. Press push button and take reading.

Auto analyser

An automated analyser is a medical laboratory instrument designed to measure different chemicals and other characteristics in a number of biological samples quickly, with minimal human assistance.

These measured properties of blood and other fluids may be useful in the diagnosis of disease.

An auto analyser sequentially measures blood chemistry through a series of steps of mixing, reagent reaction and colorimetric measurements. So it is called continuous flow analysis (CFA).

It consists of the following.

a) Sampler: Aspirates samples, standards, wash solutions into the system

b) Proportioning pump: Mixes samples with the reagents so that proper chemical color reactions can take place, which are then read by the colorimeter

c) Dialyzer: separates interfacing substances from the sample by permitting selective passage of sample components through a semi permeable membrane

d) Heating bath: Controls temperature (typically at 37 °C), as temp is critical in color development

e) Colorimeter: monitors the changes in optical density of the fluid stream flowing through a tubular flow cell. Color intensities proportional to the substance concentrations are converted to equivalent electrical voltages. [a] Recorder: Displays the output information in a graphical form.

These instruments typically determine levels of albumin, alkaline phosphates, aspartate transaminase (AST), blood urea nitrogen,bilirubin, calcium, cholesterol, creatinine, glucose, inorganic phosphorus, proteins, and uric acid in blood serum or other bodily samples.

Types of analyzers

Semi-auto analyzer: Here, the samples and reagents are mixed and read manually

Batch analyzer: The reagent mixture is mixed and fed automatically. One reagent is stored in the machine at a time enabling one batch of a specific test to be automatically conducted e.g. RA 100.

Random Access auto analyzers: These analyzers can store more than one reagent. Samples are placed in the machine and the computer is programmed to carry out any number of selected tests on each sample e.g. Hitachi 912

Some of the terms commonly used in auto analysers are:

Batch analysis wherein several samples are processed for analysis in the same analytical run.

one after another and the results are printed in the sequential order that they are fed.

Continuous flow analysis Here the samples of one batch are sequentially subjected to the same analytical reactions at the same rate, each sample being separated from the previous one by air.

Sequential analysis, where each sample in the batch enters the analytical process

Single channel analysis (single test analysis) each of the samples is analysed by a single process. Result of a single parameter is produced.

Multiple channel analysis (multiple test analysis) each of the samples is subjected to multiple analytical processes and sets of test results are obtained.

Random access analysis: Any sample may be analysed at random by a signal to the processing system. eg. of such systems are Ektachem, Hitachi 912 etc.

Familiarise the parts and working of table top centrifuge.

http://www.who.int/medical_devices/innovation/hospt_equip_9.pdf

Basic working principle

In a solution, particles whose density is higher than that of the solvent sink (sediment), and particles that are lighter than it float to the top. The greater the difference in density, the faster they move. If there is no difference in density (isopycnic conditions), the particles stay steady.

The centrifuge works using the sedimentation principle, where the centripetal acceleration causes denser substances and particles to move outward in the radial direction. At the same time, objects that are less dense are displaced and move to the center.

Tabletop Centrifuge

Low-speed tabletop centrifuges generally operate at up to 10,000 revolutions per minute (rpm) and may be non-refrigerated or refrigerated. Low-speed tabletop centrifuges are used primarily to spin red blood cells.

High-speed centrifuges generally operate at 10,000 to 30,000 rpm and some are refrigerated to cool the rotor chamber. High-speed tabletop centrifuges units are used for most preparative applications and can collect microorganisms, cells, cellular debris, and precipitates. They can also separate viruses and cellular organelles.

Product parts

Basic centrifuge components include

1. An electric motor, a shaft and rotor heads on which the centrifuge head turns, and a motor drive assembly.
2. If the centrifuge is refrigerated, a compressor and associated components are included.
3. The centrifuge head contains the cups or shields that cover the rotor and turns on a spindle.
4. Other basic components include a power switch, braking device, potentiometer, timer and tachometer.
5. Some models are equipped with an LCD (liquid crystal display) or LED (light-emitting diode) display and a keyboard.

working of table top centrifuge

Operator loads the samples into the rotor head within the instrument housing, and closes the lid.

The appropriate time, rpm, braking, and temperature (if refrigerated) information is programmed, usually by flipping a switch, by adjusting a potentiometer, or by using a keyboard.

Some units also permit selection of the degree of braking to be applied to the shaft following centrifugation.

Lab and Blood Bank Instruments

1. Compound Microscope

Parts, operation and maintenance of compound microscope.

Diagram

Parts of compound microscope

Adjustments of compound microscope namely low power high power and oil immersion objectives.

Procedure of focusing a microscope

Care of compound microscope.

2. Photoelectric colorimeter

To study the operation of photoelectric colorimeter and determine the concentration of unknown solution.

Principle

Block diagram

Procedure

Uses.

3. pH Meter

Study the operation of pH meter and to find the pH of a given solution.

Principle

Parts

Procedure

Applications.

4. Prepare an album containing list of equipments and its use in medical lab and blood bank by doing OJT or conducting a field visit.

TE QUESTIONS

1. Explain the working principle of compound microscope using image formation diagram.
2. Prepare a list of optical and mechanical parts of a compound microscope
3. A slide has to be viewed under high power objective lens of microscope. List out the steps for adjustments to be done for the same.
4. State the working principle of photoelectric colorimeter.
5. Draw the block diagram of photoelectric colorimeter and explain its parts.
6. pH value of human venous blood is ----------.
7. Explain the commonly used pH electrodes.
8. Draw the block diagram of pH meter and explain its parts.
9. pH is defined as -------------

Electrolyte analyser

Electrolyte analyzer test object is diverse, whether serum or whole blood or plasma can, urine sample, dialysis fluid samples from even liquid can also directly measure the hydration, is the function is very powerful a medical instrument. Electrolyte analyzer can detect the inorganic salt ions, sample calcium ions tiny material, etc.

Now let's introduce electrolyte analyzer principle of work:

Electrolyte analyzer have use ion selective electrode method to achieve precise measurement of the testing. The apparatus are six electrodes: sodium, potassium and chlorine, calcium ions, lithium and CST electrode. Each electrode has a ion selective film, will be measured and samples corresponding ion responses, the membrane is a ion exchanger, and ionic charge reaction and change the membrane potential, it can detect the liquid, samples and membrane potential between. Film on both sides of the two electric potential tested value will produce the current, samples, reference electrode, reference electrode liquid form "loop" side, membrane, internal electrodes liquid, internal electrodes are the other side.

Internal electrodes fluid and sample the difference between the concentration of the ions will work on both sides of the film electrode in create electrochemical voltage, through high voltage of the conductance of the internal electrodes to lead to the amplifier, reference electrode also led to the location of the amplifier. Through the test a known precisely the concentration of the ions standard solution for calibration curve, and the test sample the concentration of the ions.

Only provides the electrolyte analyzer perlong medical treatment for users to serve as reference.

Electrolyte analyser

BLOOD GAS ANALYSER

An arterial blood gas (ABG) test is a blood gas test of blood from an artery; it is thus a blood test that measures the amounts of certain gases (such as oxygen and carbon dioxide) dissolved in arterial blood. An ABG test involves puncturing an artery with a thin needle and syringe and drawing a small volume of blood. The most common puncture site is the radial artery at thewrist,[1] but sometimes the femoral artery in the groin or other sites are used. The blood can also be drawn from an arterial catheter. An ABG test measures the blood gas tension values of arterial oxygen tension (PaO2), arterial carbon dioxide tension (PaCO2), and acidity (pH). In addition, arterial oxygen saturation (SaO2) can be determined. Such information is vital when caring for patients with critical illness or respiratory disease. Therefore, the ABG test is one of the most common tests performed on patients in intensive care units (ICUs). In other levels of care, pulse oximetry plus transcutaneous carbon dioxide measurement is an alternative method of obtaining similar information less invasively.

BLOOD GAS ANALYSER

Incubator

In microbiology laboratory incubators are used to grow bacteria at temperature preferably 37 c .It can give temperature 30 - 100 C., thermostatically controlled .Heated using electric coil and is made up of double walled gun metal or stainless steel chamber.

Hemoanalysers

Hematology analysers are automatic analysers which give all hamatilogical investigations at a mtime. Automated cell counters sample the blood, and quantify, classify, and describe cell populations using both electrical and optical techniques. Electrical analysis involves passing a dilute solution of the blood through an aperture across which an electrical current is flowing. The passage of cells through the current changes the impedance between the terminals (the Coulter principle). A lytic reagent is added to the blood solution to selectively lyse the red cells (RBCs), leaving only white cells (WBCs), and platelets intact. Then the solution is passed through a second detector. This allows the counts of RBCs, WBCs, and platelets to be obtained. The platelet count is easily separated from the WBC count by the smaller impedance spikes they produce in the detector due to their lower cell volumes.

BLOOD BANK EQUIPMENTS

Blood bank equipments include the following equipments.

Blood bank refrigerators, Blood bank centrifuges, cryo centrifuge, cryo bath, deep freezers, Apheresis machines, donor couch, blood bag sealer, platelet agitator, blood shaker.

The blood bank refrigerator is an essential piece of equipment in the immunohematology department and provides safe and convenient storage of whole blood, blood components (e.g., blood cells, plasma), and reagents. Blood bank refrigerators ensure freshness and integrity of blood and blood components.

The refrigeration system includes an electrically powered compressor, a condenser, a capillary tube or expansion valve, an evaporator, and interconnecting tubing. A thermostat regulates the refrigerator temperature. In many models, the compressor and motor are connected to the same shaft and sealed in a compact, airtight compartment, making more space available for storage. Systems are either cylindrical with rotating shelves or rectangular with pullout drawers or shelves. A temperature alarm is either included or optional. An emergency power system is necessary in the event of a power failure. Configurations include tabletop, or floor units.

UNIT : 5

Dialysis Equipment

Unit 5 - Dialysis Equipments

3.5.1 Identify the importance and types of dialysis.

3.5.2 Familiarise haemo dialysis machine.

Dialysis is the removal of waste materials and toxic substancesand restoration of normal volume and composition of body fluid by means of an artificial kidney.

Dialysis, (diàlysis, meaning dissolution,, dià, meaning through, and , l?sis, meaning loosening or splitting) is a process for removing waste and excess water from the blood and is used primarily as an artificial replacement for lost kidney function in people with kidney failure.

Dialysis may be used for those with an acute disturbance in kidney function (acute kidney injury, previously acute renal failure) or progressive but chronically worsening kidney function-a state known as chronic kidney disease .

The kidneys have important roles in maintaining health. When healthy, the kidneys maintain the body's internal equilibrium of water and minerals (sodium, potassium, chloride, calcium, phosphorus, magnesium, sulfate). The acidic metabolism end-products that the body cannot get rid of via respiration are also excreted through the kidneys. The kidneys also function as a part of the endocrine system, producing erythropoietin, calcitriol and renin. Erythropoietin is involved in the production of red blood cells and calcitriol plays a role in bone formation.

Dialysis is an imperfect treatment to replace kidney function because it does not correct the compromised endocrine functions of the kidney. Dialysis treatments replace some of these functions through diffusion (waste removal) and ultrafiltration .

Severe dysfunction of kidney is treated by dialysis.Dialysis is carried out by a machine called artificial kidney.The artificial kidney is used in conditions like acute renal failure due to circulatory shock or mercury poisining and chronic or permanent renal failure.

Principle of dialysis

Dialysis works on the principles of the diffusion of solutes and ultrafiltration of fluid across a semi-permeable membrane. Diffusion is a property of substances in water; substances in water tend to move from an area of high concentration to an area of low concentration.

Blood flows by one side of a semi-permeable membrane, and a dialysate, or special dialysis fluid, flows by the opposite side. A semipermeable membrane is a thin layer of material that contains holes of various sizes, or pores. Smaller solutes and fluid pass through the membrane, but the membrane blocks the passage of larger substances (for example, red blood cells, large proteins). This replicates the filtering process that takes place in the kidneys, when the blood enters the kidneys and the larger substances are separated from the smaller ones in the glomerulus.

TYPES OF DIALYSIS

The two main types of dialysis, hemodialysis and peritoneal dialysis, remove wastes and excess water from the blood in different ways.

Hemodialysis removes wastes and water by circulating blood outside the body through an external filter, called a dialyzer, that contains asemipermeable membrane. The blood flows in one direction and the dialysate flows in the opposite. The counter-current flow of the bloodand dialysate maximizes the concentration gradient of solutes between the blood and dialysate, which helps to remove more urea andcreatinine from the blood. The concentrations of solutes (for example potassium, phosphorus, and urea) are undesirably high in the blood, but low or absent in the dialysis solution, and constant replacement of the dialysate ensures that the concentration of undesired solutes is kept low on this side of the membrane.

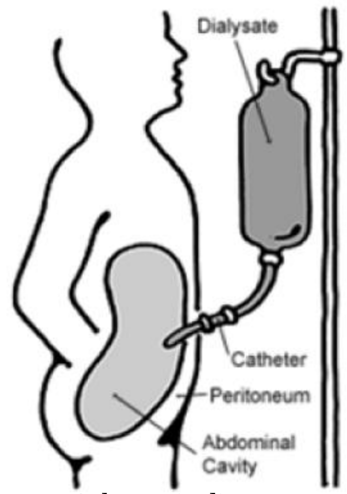
The dialysis solution has levels of minerals like potassium and calcium that are similar to their natural concentration in healthy blood. For another solute, bicarbonate, dialysis solution level is set at a slightly higher level than in normal blood, to encourage diffusion of bicarbonate into the blood, to act as a pH buffer to neutralize the metabolic acidosis that is often present in these patients. The levels of the components of dialysate are typically prescribed by a nephrologist according to the needs of the individual patient.

In peritoneal dialysis, wastes and water are removed from the blood inside the body using the peritoneum as a natural semipermeable membrane. Wastes and excess water move from the blood, across the peritoneal membrane, and into a special dialysis solution, called dialysate, in the abdominal cavity.

Peritoneal dialysis

In peritoneal dialysis, a sterile solution containing glucose (called dialysate) is run through a tube into the peritoneal cavity, the abdominalbody cavity around the intestine, where the peritoneal membrane acts as a partially permeable membrane. The peritoneal membrane or peritoneum is a layer of tissue containing blood vessels that lines and surrounds the peritoneal, or abdominal, cavity and the internal abdominal organs (stomach, spleen, liver, and intestines).

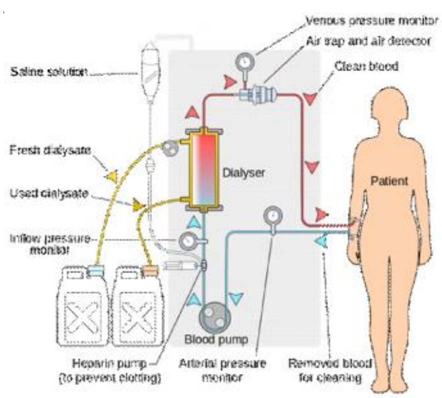
Diffusion and osmosis drive waste products and excess fluid through the peritoneum into the dialysate until the dialysate approaches equilibrium with the body's fluids. Then the dialysate is drained, discarded, and replaced with fresh dialysate.



Schematic diagram of peritoneal dialysis

HEMO DIALYSIS

Patients arterial blood is passed continuously or intermittently through the artificial kidney and then to the body through the vein. Heparin is used as an anticoagulant while tha blood is passing through the machine.Inside the artificial kidney, the blood passes through a dialyser called hemofilter, which contains minute channels interposed between two cellophane membranes.The cellophane menbraanes are porous in nature.The outer surface of these membranes is bathed by the dialysing fluid called dialysate. The used dialysate is onstantly replaced by fresh dialysate.



Urea,creatinine,phosphate and other unwanted substances from the blood pass into the dialysate by concentration gradient.The essential substances required by the body diffuse fron dialysate into blood.

In addition to the dialyser, the machine has several blood pumps with pressure monitors which enables easy flow o f blood from patient ot the machine and back to the patient. It also has pumps for flow of fesh dialysate and for drainage of used dialysate.

PRACTICAL

Dialysis Equipment

1. Field visit to haemo dialysis room and preparation of field visit report.

TE QUESTIONS

1. What is the importance of dialysis?
2. Distinguish between haemo dialysis and peritoneal dialysis

UNIT 6

Therapeutic Equipments

Introduction to types of therapeutic equipments- Radiotherapy , physiotherapy ,phototherapy, magneto therapy equipment. Radiotherapy Equipment -

Physiotherapy equipment - Short wave diathermy, microwave diathermy, ultrasound diathermy, nerve and muscle stimulators, TENS, IFT, IR lamps, CPRM, (NAMES AND USES ONLY IS REQUIRED.)

Unit 6 - Therapeutic Equipment

3.6.1 Name and uses of radio therapeutic equipment.

3.6.2 Naming and uses of physiotherapy equipment

Therapeutic Equipment

Name and uses of radio therapeutic equipment.

Introduction

Radiotherapy is the techninique of appying radiations for therapeutic urpoes.

Cancer is one of the leading causes of death in the world. It is managed by one or combination of three methods of treatment: surgery, chemo therapy, and radiation therapy. More than half of all cancer patient receive radiation therapy either as primary or adjunctive treatment. Radiation therapy is given to the patient from one of the two types of sources: gamma rays from radioactive materials or X rays from a particle accelerator.

1. Use of HV X ray machine

Before 1951 radiation therapy was carried out by X-ray machine operating at tube voltage in the range 400 kV. They are bulky difficult to operate and maintain. As a result they did not receive wide acceptance.

2. Betatron

The betatron produces high energy X ray beam as well as several electron beam of various enegy.Because of their greater penetration through thick body section betatron were found to be well suited for treating tumors of the chest and pelvis.

They are also not popular because of heavy weight, size and difficulty in the operating procedure of equipment.

3. Linear Accelerator

A linear accelerator (LINAC) is the device most commonly used for external beam radiation treatments for patients with cancer. The linear accelerator is used to treat all parts/organs of the body. It delivers high-energy x-rays to the region of the patient's tumor.

4. Intensity modulated radiation therapy (IMRT)

Intensity-modulated radiation therapy (IMRT) is an advanced type of radiation therapy used to treat cancer and noncancerous tumors. IMRT uses advanced technology to manipulate photon and proton beams of radiation to conform to the shape of a tumor.

5. Gamma Knife Radio surgery machine

The principle of Gamma Knife treatment is the delivery of high-dose ionizing radiation through 201 cobalt-60 sources. It can treat even the most challenging, hard-to-reach brain tumors and abnormalities that traditional brain surgery can't. It doesn't require incisions, so there's no general anesthesia and no risk of bleeding or infection. The side effects, such as headaches and nausea, are rare and usually temporary. It exposes patients to less radiation than other types of radio surgery.

6. Cyber knife

The Cyber Knife Robotic Radio surgery System is a non-invasive alternative to surgery for the treatment of both cancerous and non-cancerous tumors anywhere in the body, including the prostate, lung, brain, spine, liver, pancreas and kidney. The treatment - which delivers beams of high dose radiation to tumors with extreme accuracy.

Phototherapy Equipment

A treatment for jaundice in the newborn that involves the exposure of an infant's bare skin to intense fluorescent light.

Phototherapy treatment help reduce the amount of bilirubin pigment in the skin.
Brachytherapy
The treatment of cancer, especially prostate cancer, by the insertion of radioactive implants directly into the tissue.
IR lamps, CPRM

3.6.2 Naming and uses of physiotherapy equipment.

Diathermy machine in Physiotherapy
Diathermy is a therapeutic treatment through heating. In diathermy, a high-frequency electric current is delivered via shortwave, microwave, or ultrasound to generate deep heat in body tissues. This is most commonly prescribed for joint conditions such as rheumatoid arthritis and osteoarthritis.
There are

1. Short wave diathermy machine

Short-wave radio frequencies in the range 1-100 MHz (shortwave diathermy)
As the high-frequency waves travel through the body tissues between the condensers or the coils, they are converted into heat. The degree of heat and depth of penetration depend in part on the absorptive and resistance properties of the tissues that the waves encounter.
Short wave diathermy usually is prescribed for treatment of deep muscles and joints that are covered with a heavy soft-tissue mass, for example, the hip. In some instances short wave diathermy may be applied to localize deep inflammatory processes.

2. Ultrasound diathermy machine

Employs high-frequency acoustic vibrations which, when propelled through the tissues, are converted into heat. This type of diathermy is especially useful in the delivery of heat to selected musculatures and structures because there is a difference in the sensitivity of various fibers to the acoustic vibrations; some are more absorptive and some are more reflective. For example, in subcutaneous fat, relatively little energy is converted into heat, but in muscle tissues there is a much higher rate of conversion to heat.

Microwaves diathermy machine

The frequency of micro wave is 300 MHz or 30000 MHz Microwave diathermy is used in the management of superficial tumours with conventional radiotherapy and chemotherapy.

External muscle stimulator

Electrical muscle stimulator (EMS), also known as neuromuscular electrical stimulator (NMES) or electromyostimulator stimulate the muscle using electric impulses. The various uses are as follows.

- Relaxation of muscle spasms;

- Prevention or retardation of disuse atrophy;
- Increasing local blood circulation;
- Muscle re-education;

Transcutaneous electrical nerve stimulation (TENS or TNS)

Transcutaneous electrical nerve stimulation (TENS or TNS) is the use of electric current produced by a device to stimulate the nerves for therapeutic purposes.

It is worth noting that the term TENS could represent the use of ANY electrical stimulation using skin surface electrodes which has the intention of stimulating nerves. EMS and TENS devices look similar, with both using long electric lead wires and electrodes. TENS is for blocking pain, where EMS is for stimulating muscles.

Interferential Therapy

The basic principle of Interferential Therapy (IFT) is to utilise the significant physiological effects of low frequency electrical stimulation of nerves without the associated painful and somewhat unpleasant side effects sometimes associated with low frequency stimulation. Recently, numerous 'portable' interferential devices have become easily available. Despite their size, they are perfectly capable of delivering 'proper' interferential therapy, though some have limited functionality and ability for the practitioner to 'set' all parameters. Most multifunction stimulators include all interferential modes,

Spinal cord stimulator

Spinal cord stimulatation is a term relating to the use of electrical stimulation of the human spinal cord for the relief of pain

Magnetic stimulation

A problem with eclectic stimulation is that it is pain full. It is also possible to stimulate both brain and nerve magnetically. Magnetic pulse is generated by passing a brief high current pulse though a coli of wire. The technique has an advantage in that the stimulation is painless.

Infrared Curing Lamp

Infrared energy is a form of radiation, which falls between visible light and microwaves in the electromagnetic spectrum

An infrared heater or heat lamp is a body with a higher temperature which transfers energy to a body with a lower temperature through electromagnetic radiation. Depending on the temperature of the emitting body, the wavelength of the peak of the infrared radiation ranges from780 nm to 1 mm. No contact or medium between the two bodies is needed for the energy transfer. Infrared heaters can be operated in vacuum or atmosphere.

Unit 7:
Biomedical Waste Management

Hospital waste or Health care waste are produced from a hospital. Hospital waste means Any solid os liquid waste material including is container and any other intermediate product which is generayed during short term or lomg term care consisting of observational , diagnostic ,therapeutic, and rehabilitative services, for a person suffering from disease,injury and foe parturient or during research pertaining to production and testing of biological during immunization of human beings.

Biomedical waste management is now a days very important in a multispecialty hospital. If proper care is not taken for waste management ,it may cause hazardous effects in people and environment like infections ,water, air and soil pollution.it may also lead to many health hazards. This unit deals with types of biomedical waste, equipment used for its management in a hospital.

SYLLABUS

- Introduction to biomedical waste - definition and classification of biomedical waste., steps in waste management, segregation, collection, storage, transportation, disposal - equipment used, autoclave, incinerator, safety aspects regarding biomedical waste.

Learning outcomes

3.7.1 Classification of biomedical waste

3.7.2 Identify the steps in biomedical waste management.

3.7.3 Identify the methods of disposal of waste.

3.7.4 Identify the equipment used in waste management.

Biomedical waste :

Definition

Biomedical waste : Any waste generated during diagnosis, treatment, or immunization of human beings or animals or research activities.Biomedical wate include clinical waste, laboratory waste, non-clinical waste, kitchen waste and radioactive waste.

Biomedical waste are the following

Category 1 : Human anatomical waste

Category 2 : Animal waste

Category 3 : Microbiology and biotechnology wate

Category 4 : Sharps

Category 5 : Cytotoxic drugs and medicines

Category 6 : Soiled waste

Category 7 : Solid waste

Category 8 : liquid waste

Category 9 : Incineration ash

Category 10 : Chemical waste

The hospital waste management program

1. Generation and segregation of waste
2. Collection and storage of waste
3. Transportation of water
4. Treatment of waste
5. Treatment of waste
6. Disposal of waste

Colour coding for collection of biomedical waste

Sl no	Category of waste	Recommended colour code
1	Syringe,blood bag,catheters,etc.	Red
2	Sharps (Infected or not)	White
3	Infected waste (not containing sharps)	Yellow
4	Chemical and pharmaceutical waste (other than cytotoxic drugs, radio active wastes, high pressure containers	Black
5	Clinical waste that need autoclaving	blue

Segregation of waste is defined as the separation of different types of waste by sorting at the site of collection.

Collection of hospital waste is the process ,which is done after segregation, and in a way, both can be considered as being complimentary to each other. several guidelines are given by WHO, and other statutory rules in our country.

Storage is the duration of time the wastes are kept in the area of generation and transit, till the point of disposal.

Transportation is the way of transferring the waste to the processing and disposal centers. Vehicles for external transport include van, lorry properly labeled and obeying all statutory rules of BMW Management.

Processes include liming, incineration, sanitary landfills, autoclaving, microwave technology, hydropulping, landfill, pit burial, composting etc.. The technique depends on the type of waste and method adopted.

Biomedical waste management and handling rules 1998 and Kerala state Pollution control board guidelines are usually followed for these purposes.

Unit : 8

Audiometry

Audiometry is a branch which deals with the investigations of auditory disfunction. Investigations are done to differentiate between different types of hearing loss.

Audiometer is an instrument used for diagnosing the degree of deafness. Pure tone audiometer is commonly used for this purpose.

Pure tone audiometry investigates the difference between the sound pressure level required to produce hearing in the individual under test and that required to produce hearing in an average normal person. It is very helpful in evaluating the functional status of the auditory system, to predict the outcome of surgical procedures and to assess the value of therapeutic measures and selection of hearing aid.

This unit covers the structure of ear, mechanism of hearing, types of audiometers, parts of audiometer and hearing aids .

Unit 8 - Audiometry

3.8.1 Understand the anatomy of ear and mechanism of hearing.

3.8.2 Identify pure tone audiometer and speech tone audiometer.

3.8.3 Identify the parts and operation of pure tone audiometer.

3.8.4 Identify the types and uses of hearing aids

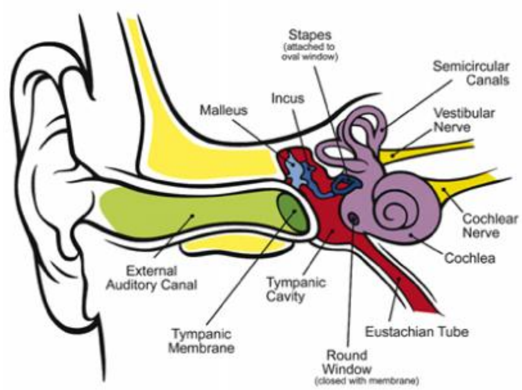
Ears are the reception organs of sound. The ear consists of three parts.

1. External Ear
2. Middle Ear
3. Inner Ear

External Ear

External ear consists of pinna, auditory canal and tympanic membrane.

The outermost part of the ear is called Pinna or auricle. Pinna is a tunnel like flap of cartilage and skin which serves to direct the sound waves into the auditory canal. The auditory canal is a



Structure of Ear

convoluted tubeof volume of about 1 cm. The auditory canal terminates at tympanic membrane.

Middle Ear

The tympanic membrane is followed by the middle ear cavity. It is exposed to atmospheric pressure only through the Eustachian tube which is connected to pharynx and nose or mouth. The middle ear consists of a chain of three small bones known as males, Incus and Stapes.

Inner Ear

The inner ear is coupled to the middle ear cavity through a very small membrane called the oval window. The inner ear or cochlea is a filled rolled coiled passage in the temporal bone.

Mechanism of Hearing

Sound waves are longitudinal waves. These waves generate pressure changes in the medium [air] which is picked up by our aural mechanism. Sound waves from the outer ear travels through the auditory canal and pushes against the tympanic membrane. The distance upto which the membrane moves is a measure of loudness of sound. The sound pressure incident on the tympanic membrane is transmitted to the inner ear through the chain of bones and oval window. The receptor cells of the cochlea transforms the sound energy into action potential. These action potentials are transmitted to the brain through the auditory nerve with a speed of 100 m/s.

Pure Tone Audiometers

Pure tone audiometry is the most widely used technique for determining the hearing loss. Pure tone audiometer produces test tones in octave steps from 125 to 8000 Hz.

A pure tone audiometer basically consists of an LC oscillator having an inductance and tuning capacitance of close tolerance. The oscillator is coupled to an output amplifier stage to produce the required power levels. The sound signals are directed to the ear acoustically by means of an earphone or a loud speaker. Then the responses are recorded.

Speech audiometer

These are used to carry out tests with spoken voices. These tests are carried out with spoken voices. These tests are done for prescribing hearing aids.

Speech audiometer uses a tape recorder for producing speech stimuli. The spoken voice from the tape recorder is presented acoustically to the ear via a pair of headphones. A noise generator is also provided for generating the masking noise.

Speech audiometer also incorporates live voice facilities. But it is of very little use owing to unreliability of live voice speech tests.

TE QUESTIONS

1. Bones in the middle ear are --------, --------------- and --------------.
2. Audible range of frequency of human ear is -------------- to --------------- Hz.
3. Explain the mechanism of hearing.
4. Name the transducers used in audiometer.
5. State and explain the types of audiometers.
6. Distinguish between pure tone audiometer and speech audio mater.
7. List out the different types of hearing aids and its applications.

Unit : 9

Major Equipment In Other Department

LEARNING OBJECTIVES

3.9.1 Familiarise the applications of fibre optics in medicine.

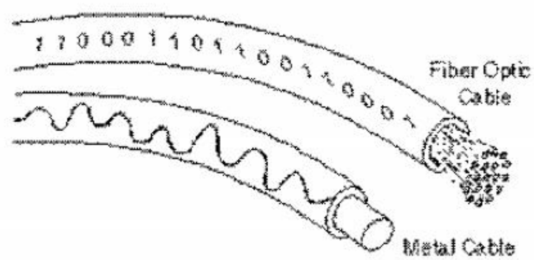
3.9.2 List out the equipment based on fibre optics, endoscope, laproscope, bronchoscope and laryngoscope.

3.9.3 Familiarise other engineering services in a hospital - Civil, Electrical, mechanical, and computer engineering.

Note: Name and uses only is required.

OPTICAL FIBERS IN MEDICINE

An optical fiber (or optical fibre) is a flexible, transparent fiber made by drawing glass (silica) or plastic to a diameter slightly thicker than that of a human hair.[1] Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than wire cables. Fibers are used instead of metal wires because signals travel along them with lesser amounts of loss; in addition, fibers are also immune to electromagnetic interference, a problem from which metal wires suffer excessively.[2][3] Fibers are also used forillumination, and are wrapped in bundles so that they may be used to carry images, thus allowing viewing in confined spaces, as in the case of a fiberscope.[4] Specially designed fibers are also used for a variety of other applications, some of them being fiber optic sensorsand fiber lasers.[5]



Optical fibers typically include a transparent core surrounded by a transparent cladding material with a lower index of refraction. Light is kept in the core by the phenomenon of total internal reflection which causes the fiber to act as a waveguide.[6] Fibers that support many propagation paths or transverse modes are called multi-mode fibers (MMF), while those that support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally have a wider core diameter and are used for short-distance communication links and for applications where high power must be transmitted.[citation needed] Single-mode fibers are used for most communication links longer than 1,000 meters (3,300 ft).[citation needed]

An important aspect of a fiber optic communication is that of extension of the fiber optic cables such that the losses brought about by joining two different cables is kept to a minimum.[7] Joining lengths of optical fiber often proves to be more complex than joining electrical wire or cable and involves careful cleaving of the fibers, perfect alignment of the fiber cores, and the splicing of these aligned fiber cores. For applications that demand a permanent connection a mechanical splice which holds the ends of the fibers together mechanically could be used or a fusion splice that uses heat to fuse the ends of the fibers together could be used. Temporary or semi-permanent connections are made by means of specialized optical fiber connectors.[8]

The field of applied science and engineering concerned with the design and application of optical fibers is known as fiber optics.

A technology that uses glass (or plastic) threads (fibers) to transmitdata. A fiber optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.

Fiber optics has several advantages over traditional metal

Optical fibres can also have applications in: - Medicine - Biological and genetics research - Defence - Industrial materials processing - Chemical and pollution sensing - Next generation lasers - Optical data processing - Transmitting light beyond the near-IR

ENDOSCOPE

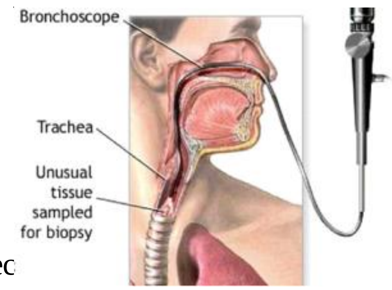
Endoscopy means looking inside and typically refers to looking inside the body for medical reasons using an endoscope, an instrument used to examine the interior of a hollow organ or cavity of the body. Unlike most other medical imaging techniques, endoscopes are inserted directly into the organ.

There are many different types of endoscope, and depending on the site in the body and the type of procedure, endoscopy may be performed by a doctor or a surgeon, and the patient may be fully conscious or anaesthetised. Most often the term endoscopy is used to refer to an examination of the upper part of the gastrointestinal tract,known as an esophagogastroduodenoscopy.[1]

For non-medical use, similar instruments are called borescopes.

LIGHT SOURCES

- Tungsten filament lamp
- Halogen reflector lamp
- optimal use of light
- Rare-earth xenon lamp
- high intensity light
- true color display (xenon daylight effec



For example broncoscope

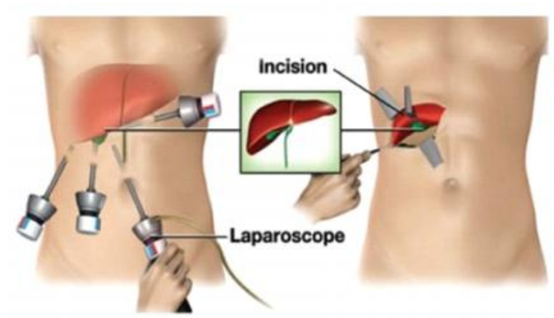
Optical fibres are narrow tubes of glass fibres with a plastic coating that carry light from one end to the other. The light bounces off the walls of the fibre and can even bounce around corners. The properties of optical fibres make them useful for a wide range of applications including:

- Medical - to transmit pictures of organs and arteries
- Fiber optic technology is opening exciting new fields of application in the medical industry. The physical
- characteristics of fiber make it a natural choice for many uses. Optical fiber has become widely used in imaging,
- laser delivery systems, illumination, sensors and equipment interconnects. Optical fibers provide a compact and
- flexible conduit for light or data delivery in diagnostic and interventional medical applications. In order to be
- effec tive, optical fibers require robust, precise interconnects that integrate seamlessly into the medical theater.
- Diamond has the expertise to make these interconnects a reality.
- Fiber optic solutions applicable for several medical sectors, such as:
- ILLUMINATION
- IMAGE TRANSFER
- DIAGNOSTIC DEVICES

- SURGICAL INSTRUMENTATION
- THERAPEUTIC APPLICATIONS

Laparoscopic surgery, also called minimally invasive surgery (MIS), bandaid surgery, or keyhole surgery, is a modern surgicaltechnique in which operations are performed far from their location through small incisions (usually 0.5-1.5 cm) elsewhere in the body.

There are a number of advantages to the patient with laparoscopic surgery versus the more common, open procedure. Pain and hemorrhaging are reduced due to smaller incisions and recovery times are shorter. The key element in laparoscopic surgery is the use of a laparoscope, a long fiber optic cable system which allows viewing of the affected area by snaking the cable from a more distant, but more easily accessible location.



Laparoscopic Cholecystectomy   Open Cholecystectomy

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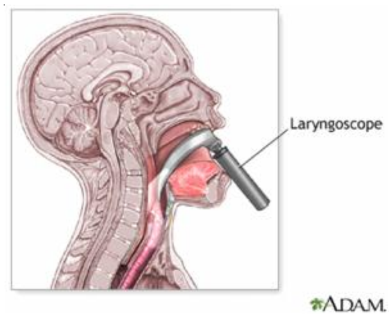
Laryngoscopy (larynx + scopy) is a medical procedure that is used to obtain a view of the vocal folds and the glottis. Laryngoscopy may be performed to facilitate tracheal intubation during general anesthesia or cardiopulmonary resuscitation or for procedures on the larynx or other parts of the upper tracheobronchial tree.

With a global population that's both growing and living longer, the world's healthcare providers are increasingly looking to advanced biomedical instrumentation to enable more efficient patient diagnosis, monitoring, and treatment. In this context, biomedical sensing applications of optical fiber are of growing importance. At the same time, recent advances in minimally invasive surgery (MIS) demand smaller disposable sensing catheters.



Endoscopic imaging applications of fiber-optics are well established, but the intrinsic physical characteristics of optical fibers also make them extremely attractive for biomedical sensing. Uncabled fibers (typically less than 250 ?m diameter) can be inserted directly into hypodermic needles and catheters, so that their use can be both minimally invasive and highly localized-and fiber-optic sensors (FOS) made with them can perform remote multipoint and multiparameter sensing. Optical fibers are immune to electromagnetic interference (EMI), chemically inert, nontoxic, and intrinsically safe. Their use will not cause interference with the conventional electronics found in medical theaters. And, most importantly, the immunity of fibers to electromagnetic and radio frequency (RF) signals makes them ideal for real-time use during diagnostic imaging with MRI, CT, PET, or SPECT systems, as well as during thermal ablative treatments involving RF or microwave radiation.

Optical fiber sensors comprise a light source, optical fiber, external transducer, and photodetector. They sense by detecting the modulation of one or more of the properties of light that is guided inside the fiber-intensity, wavelength, or polarization, for instance. The modulation is produced in a direct and repeatable fashion by an external perturbation caused by the physical parameter to be measured. The measurand of interest is inferred from changes detected in the light property.

Extended activity

LASER

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "light amplification by stimulated emission of radiation".[1][2] The first laser was built in 1960 by Theodore H. Maiman at Hughes Research Laboratories, based on theoretical work by Charles Hard Townes and Arthur

Leonard Schawlow. A laser differs from other sources of light in that it emits light coherently. coherence allows a laser to be focused to a tight spot, enabling applications such as laser cutting and lithography. Spatial coherence also allows a laser beam to stay narrow over great distances (collimation), enabling applications such as laser pointers. Lasers can also have high temporal coherence, which allows them to emit light with a very narrow spectrum, i.e., they can emit a single color of light. Temporal coherence can be used to produce pulses of light as short as a femtosecond.

Among their many applications, lasers are used in optical disk drives, laser printers, and barcode scanners; fiber-optic and free-space optical communication; laser surgery and skin treatments; cutting and welding materials; military and law enforcement devices for marking targets and measuring range and speed; and laser lighting displays in entertainment.

Medical areas that employ lasers include:

- angioplasty
- cancer diagnosis
- cancer treatment
- cosmetic dermatology such as scar revision, skin resurfacing, laser hair removal, tattoo removal
- dermatology to treat melanoma
- lithotripsy
- laser mammography
- medical imaging
- microscopy
- ophthalmology (includes Lasik and laser photocoagulation)
- optical coherence tomography
- prostatectomy
- plastic surgery, in laser liposuction
- surgery to ablate and cauterize tissue

Engineering Services

Engineering and maintenance department is responsible for ensuring safe and economical operation and maintenance of hospital facilities and,nsive equipment.The department should be capable of providing technical and management support .It is responsible for the preventive maintenance, inventory control,repair and uninterrupted supply of power also.

Engineering servicing other than Biomedical engineering are

1. Electrical Engineering
2. Mechanical Engineering
3. Civil Engineering.

All these services in a hospital have got an important role in safe health care delivery. It is responsible for maintaining a safe environment, repair of equipment, action during breakdown or an emergency situation supervision of engineering works preventive maintenance etc.

Preventive maintenance plays an important role in the equipment planning of a hospital. The engineering department is involved from the stage of framing specifications of equipments to the selection, installation and maintenance of the equipment [AMC]. The contract is mainly for maintenance, repair and other payments

Electrical Engineering

Electrical division should provide uninterrupted power supply to the hospital 24 x 7.

It mainly consists of

- Electrical substation
- Generator room for uninterrupted power supply.
- HT & LT electrical installation and associated accessories.
- Other electrical accessories

Mechanical Services

Mechanical services include steam boilers, Linen and Laundry, Dietary equipment, housekeeping equipment, sterilization equipment, mechanical medical equipment like hydraulic bed, wheel chair, physiotherapy equipment etc.

Air conditioning division involves the following functions. Refrigerators, Deep freezers, Split A/C, Centralised A/C system including AC plant, mortuary cabinets etc.

Civil Engineering

Construction of hospital blocks and its maintenance comes under this wing.construction and maintenanceof civil nature, carpentry,painting,plumbing,etc., water supply system,waste ater drainage system ..all come under this department.

MODULE 4

Medical Imaging

Overview

Medical Imagin is the technique and process of creating visual representation of the interior of a boy for clinical analysis and medical intervention. The visual representation of the function of organs and tissues help in the diagnosis as well as treatmernt.

Medical imaging include readiography, ultrasonography, elementary details of CT, MRI, PET, SPECT and gamma camera. Rediography include radiograph prepration dtudy of X ray machine and processing. Ultrasonography includes study of ultra sound, parts of machine and its uses in medical field.

Patient safety is also included in this module. Effects of elecrticity on human body, grounding of equipment and other safety aspects are also included in this module.

Unit 1 - Introduction to radiography

4.1.1 To understand the production, properties and applications of X-rays.

4.1.2 Familiarise absorption of X-rays, unit of X-ray

4.1.3 To understand the principle of radiography.

4.1.4 To understand the block diagram of X-ray machine

4.1.5 Familiarise the types of X-ray machine, unit of X rays- Mobile,stationary, OPG, C arm

Mamography- digital X-ray.

4.1.6 Familiarise X-ray film- Construction- processing and digital processing.

4.1.7 Familiarise AERB regulations and general safety in radiography.

Effect of X-ray in human body.

X rays

X rays are electromagnetic radiations of very short wavelength coming at the end of electromagnetic spectrum and is discovered by Wilhelm Conrad Roentgen in November 1895. According to quantum theory, x-rays consist of small packets of energy

I. Properties of X-rays

1. X-rays have high penetrating power
2. Their speed in vacuum is same as that of light in vacuum i.e., 3x108 m/s
3. X-rays causes secondary emission in all matter through which they pass
4. They exhibits all phenomenon shown by light
5. They ionize gases.
6. They affect photographic films.
7. Kill living tissues
8. They do not deflect in electric field and magnetic field
9. They produce fluorescence and phosphorescence when incident on fluorescent and phosphorescent substance

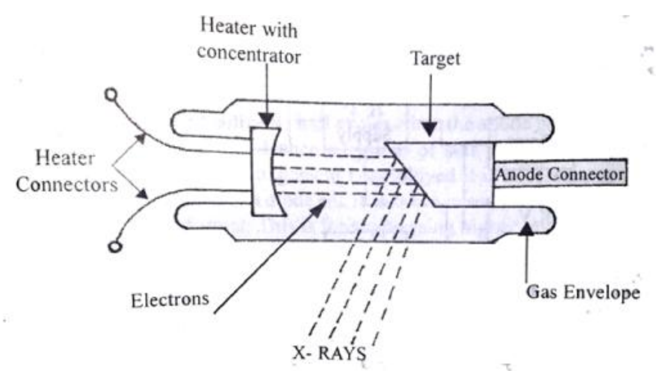
II. Applications

1. They find use in radiography, radio therapy [treatment of cancer]
2. X-rays are used in CT, angiography, mammography .
3. They are used in fluoroscopy.

III. Production of X-rays

X-rays are produced when fast moving electrons are suddenly decelerated by impinging on a target. The device used for the production of X-rays is known as X-ray tube

Working



X-Ray tube - working Principle

When the cathode is heated by passing a current through it, electrons are emitted from it. The amount of electron emitted from the cathode depends upon the heater current. The anode will be kept at very high positive potential with respect to the cathode. The electron emitted from cathode will be greatly accelerated by the very high anode voltage. These fast moving electrons are then suddenly decelerated by impinging on the target anode resulting in the production of X-rays. The target material is tungsten

The intensity of X-rays depends on the heater current. Penetrating power of X-rays depend on the target material and target voltage, the anode voltage for diagnostic of X-rays unit is 30 to 100 kV.

Two types of X-rays tubes are

(i) Stationary anode & (ii) Rotating anode

Unit of X-ray radiation

Roentgen is a measure of the quantity of X-ray radiation. The other units are milli-Roentgen and micro-Roentgen. Roentgen express incident energy, RADS give an indication of how much of this incident energy is absorbed and REM is a measure of the relative biological damage caused.

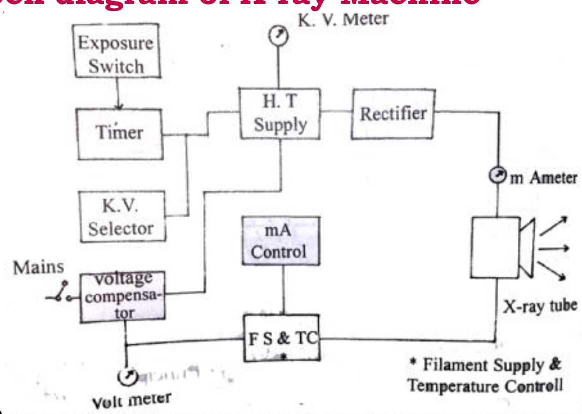
Visualisation of X-rays

Visualisation of X-rays is accomplished by means of screens. In diagnostic radiography two types of screens are used. They are intensifying screen in radiography and fluorescent screen in fluorography. Even though these two techniques are different, the physical phenomenon taking place in both the case is the same. X-rays are absorbed when passed through certain materials. These materials re-emits energy in the form of visible photons. The amount of light being emitted is proportional to the x-ray energy. Hence any pattern of intensity of x-ray beam will be converted into an identical visible pattern.

Principle of radiography

In radiography, intensifying screen may be used in conjunction with x-ray film to produce a better defined pattern of x-rays. If we allow x-rays to incident directly on the film, owing to the high energy of x-ray beam and small thickness of film, they will just pass through the film without producing well defined image. If an intensifying screen is used, the x-rays will first hit on the screen, material and get absorbed. The screen material re-emits the x-ray photons in form of visible pattern. The number of visible photons emerging from screen will be very high as compared to the number of the incident x-ray photons. Hence large number of visible photons are now available to hit the x-ray film. This increased number of photons will produce a large latent image on the film

IV. Block diagram of X-ray Machine

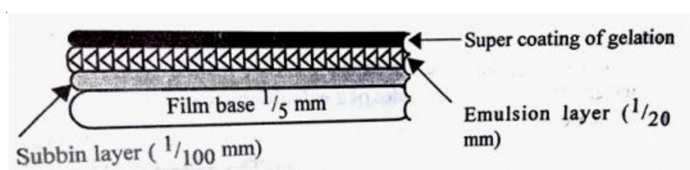


The entire circuit of an x-ray machine may be divided into two sections. One of these section is used for producing a high voltage which is applicable to the anode of the x-ray tube. It comprise of a high voltage step up transformer followed by bridge rectifier circuit. The current through the tube is measured by a millimeter. The voltage can be altered between exposures by means of a kV selector. The voltage can be measures from the kV meter. The duration of application of kV is determined by the timer which in turn is controlled by the exposure switch. The main voltage fluctuations are compensated with the help of voltage compensator

The second part of the circuit is controlling the heating of the filament. The filament is heated with 6 to 12 V of AC supply at a current of 3 to 5 Ampere. The filament temperature determines the tube current and therefore has an attached mA selector. A rheostat connected on primary of filament transformer is used for controlling the filament current

V. X-ray film

The visible pattern helpful for medical diagnosis is produced on the x-ray film. Double coated x-ray films are commonly used in radiology. In this type of film both sides are coated with photographic emulsion. During the exposure to x-ray certain changes takes place on the emulsion material resulting in the ultimate production of a visible pattern. The emulsion material consists of a thin layer of gelatin over which silver bromide crystals are suspended uniformly. There are two layer of emulsion which are supported and separated by a polyester. This is called the film base. The



film base is transparent and clear and has a light blue colour. The emulsion layers are very sensitive to pressure, temperature, light and other atmospheric conditions. The two emulsion layers are protected by thin hard layers of gelatin.

The x-ray film consist of four layers

1. Film base

This is the middle part of the film. It is made up of cellulose try acetate and has a thickness of about 1/5 mm

2. Subbin Layer

Subbin layer has a thickness of about 1/100 mm. It is made up of cellulose try acetate and gelatin

3. Emulsion Layer

This is the most important layer of the x-ray film. It has got a uniform thickness of about 1/20 mm. it is made up of silver bromide and gelatin

4. Super Coating

This layer is very thin and hard. It act as protective cover for the emulsion layer

VI. Production of Patterns on the Film

When X -rays are passed through a body, various parts of the body will absorb different quantity of X -ray energy. Hence the X -ray beam emerging from the body will have varying intensities at different portions. This beam of varying intensities is then allowed to fall on the X-ray film. Therefore different parts of the film will absorb, different number of X-ray photons. This results in the formation of an invisible image on the film. The photosensitive silver bromide crystals have already received an image of the pattern. This image known as the latent image must undergo some chemical process so as to make it visible

VII. Developing of the Film

The first stage of processing is known as developing. During this the bromide crystals which are affected during exposure are converted to tiny, opaque, black silver specks. The crystals which are not affected by X -rays remain unchanged (yellowish transparent state). The region which had exposed to a greater intensity of X-rays during exposure will look black. This is due to the large number of opaque black silver specks present there. On the other hand the region which was exposed to the lower intensity portion of the X-ray beam will have lower amount of black silver specks and will look less blackish. Hence the image is made visible)

VIII. Fixing

A visible pattern was obtained on the film through the process of developing. But the film cannot be preserved in the above form. The crystals of bromide which were not affected by X-rays should be removed from the film. At the same time the silver specks formed during developing should be fixed in the same position. This process is known as fixing. During the process of fixing, the unaffected crystals are washed away in the chemical solution while leaving the crystals containing the pattern on their earlier positions on the film. Thus the crystals containing the pattern are fixed on the film and the gelatine (super coating) gets hardened.

IX. Washing of the Film

After fixation, the chemicals present on the film should by washed away This is done by washing the film in running water for about 15 minute

X. Drying of the Film

This is the final stage of film processing. It can be done either in open air or in the drying chamber

XI. Precautions

Since the film is highly sensitive to light, utmost care should be taken while handling the film. It should not be exposed to light during processing. Hence processing should be done only in a dark room. During exposure the film is kept inside a tight box called cassette. Also the film should not be exposed to bade atmospheric conditions such as high temperature, humidity or pressure. This will result in undesirable blackening throughout the film. This condition is referred to as fog. This will reduce the contrast of radiography.

XII. Different types of X-ray machines

(i) Portable X-ray Unit

It can be dismantled, packed into a small case and conveniently carried to the site. The tube heed is so constructed that the x-ray tube and the high voltage generator are enclosed in one earthed metal case filled with oil. The x-ray is usually a small stationary anode type. The maximum radiographic output found on portable uits is in the range of 15-20 mA at 90-95 kV

(ii) Mobile X-ray unit

Mobile unit carries the control table and the column supporting the x-ray tube permanently mounted on the mobile base. Mobile units much heavier than the portable units. This units have a radiographic output of upto 300mA and a maximum of 125kV. Mobile units make use of stored energy, this may be from the capacitor discharge or battery powered inverter circuits

Mammographic x-ray machine

Mammography is an x-ray imaging procedure used for examination of female breast. It is primarily used for diagnosis of breast cancer and in the guidance of needle biopsies.

OPG (Orthopantomogram)

An OPG is a panoramic or wide view x-ray of the lower face, which displays all the teeth of the upper and lower jaw on a single film. It demonstrates the number, position and growth of all the teeth including those that have not yet surfaced or erupted. It is different from the small close up x-rays dentists take of individual teeth

c arm

C-arm is a medical imaging device that is based on X-ray technology and can be used flexibly in a clinic. The name is derived from the C-shaped arm used to connect the X-ray source and X-ray detector to one another.

The C-arm systems are commonly used for studies requiring the maximum positional flexibility such as:

Angiography studies

Therapeutic studies

Cardiac studies

Orthopedic procedures

Digital Radiography

Digital radiography is a form of X-ray imaging, where digital X-ray sensors are used instead of traditional photographic film. Advantages include time efficiency through bypassing chemical processing and the ability to digitally transfer and enhance images. Also, less radiation can be used to produce an image of similar contrast to conventional radiography.

Instead of X-ray film, digital radiography uses a digital image capture device. This gives advantages of immediate image preview and availability; elimination of costly film processing steps; a wider dynamic range, which makes it more forgiving for over- and under-exposure; as well as the ability to apply special image processing techniques that enhance overall display quality of the image.

Digital radiography is a form of X-ray imaging, where digital X-raysensors are used instead of traditional photographic film. Advantages include time efficiency through bypassing chemical processing and the ability to digitally transfer and enhance images.

AERB Regulations and General Safety In Radiography

The Atomic Energy Regulatory Board (AERB) was constituted on November 15, 1983 by the President of India by exercising the powers conferred by Section 27 of the Atomic Energy Act, 1962 (33 of 1962) to carry out certain regulatory and safety functions under the Act. The regulatory authority of AERB is derived from the rules and notifications promulgated under the Atomic Energy Act, 1962 and the Environmental (Protection) Act, 1986. The headquarters is in Mumbai

The mission of the Board is to ensure that the use of ionising radiation and nuclear energy in India does not cause undue risk to health and the environment

Ionising radiation, such as medical X-rays, is used in medicine as an essential tool for protecting and improving human health since its discovery at the end of 19th century. Over 90 % of the workload in diagnostic radiology in many countries is the general radiography and is a major contributor to the collective population dose. It is therefore essential, from the radiological safety view point, to exercise strict regulatory control over the safe use of such beneficial application of ionizing radiation. The regulatory framework for controlling safe use of ionizing radiation sources, including medical X-rays, is mainly based on the following;

- Atomic Energy Act, 1962
- Atomic Energy (Radiation Protection) Rules {AE(RP)R}, 2004
- Notification No. GSR 388 on," The Radiation Surveillance Procedures for Medical Applications of Radiation, 1989"
- The Safety Code for Medical Diagnostic X-ray Equipment and Installations {No. AERB /SC/MED-2 (Rev.1), 2001}

The national regulatory authority, i.e., Atomic Energy Regulatory Board (AERB) has been set up to carry out certain regulatory and safety functions envisaged under Sections 16, 17 and 23 of the Atomic Energy Act 1962. Chairman, AERB has been notified as the Competent Authority for the enforcement of radiation protection in the country.

The Safety Code (No. AERB /SC/MED-2(Rev.1), 2001), published by AERB is intended to govern radiation safety in design, installation and operation of X-ray equipment for medical diagnostic purposes. The implementation of provisions of the Safety Code ensures the radiation protection of occupational workers, patients and public at large. Some of the regulatory requirements of the Safety Code are:

- Only those X-ray units should be procured by the users which have been Type Approved by the Competent Authority.
- Installation and room lay-out should be in accordance with the specifications of the Safety Code.
- User should ensure that on acquisition (by purchase, transfer, gift, lease or loan) of X-ray equipment, it is registered with the Competent Authority.
- The Radiological Safety Officer (RSO) should conduct periodic radiological protection survey of X-ray installation and maintain records on routine Quality Assurance (QA) tests on X-ray unit.
- All radiation workers should use appropriate personnel monitoring badges (TLD badges).

Conclusion

Radiation safety includes

1. TLD badge-Exposure to radiation is measured using thermo luminescent do-simeter badge.
2. PPE - Personal protective equipment like lead apron , lead gloves.
3. Radioactive shielding
4. Radiation safety officers are posted for evaluation.
5. Display of safety symbols.

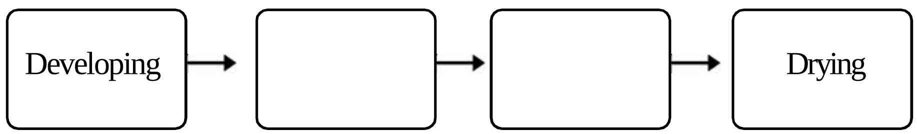
PRACTICALS

1. Implementation of 555 timer using kit.
2. Working of X ray machine [OJT]
3. Study of X ray film by collection and by using internet.

XIII. TE Questions

1. The target of x-ray tubes are made of ___________
2. Explain how x-rays are produced in x-ray tubes

3. Describe the structure and composition of an x-ray film
4. Draw block diagram of an x-ray machine and explain the function of each block
5. What are the properties of x-rays
6.



This is the flow chart of film processing in the dark room. Complete the flow chart and explain

7. X-ray was first discovered by ___________
8. The penetration depth of X-rays depend on tube___________
9. X-rays are ___________ radiations
10. The image is formed on the ___________ layer of X-ray film
11. Name the different types of X-ray machines
12. List out the odd one

    a. Filament b. Grid c. Target d. Intensifying screen

Ultra Sound Scanning

Unit 2 - Ultra sonography

4.2.1 To understand ultra sound physics

4.2.2 To understand the principle of oscillation

4.2.3 To understand the circuit diagram- working of crystal oscillator.

4.2.4 Familiarise ultra sonography.

4.2.5 To identify medical applications of ultra sonogrsphy

Oscillators

Oscillations are simply speaking vibrations of any desired frequency. A circuit which is capable of producing oscillations is known as Tank circuit. A tank circuit consists of a parallel combination of an inductor and a capacitor.

Oscillator

Oscillator is a circuit which is capable of producing oscillations of any desired frequency.

Types of Oscillators

Depending on the circuit components and type of oscillations, oscillators are divided mainly into 4 types. They are

1. Hartley Oscillator
2. Collpits Oscillator
3. Crystal Oscillator
4. RC phase shift Oscillator

Crystal Oscillator

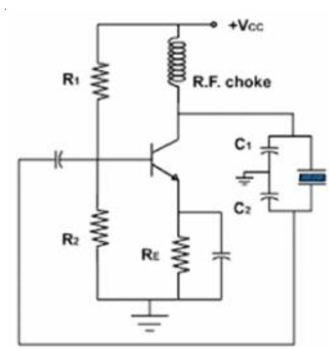
The main part of a crystal oscillator is a crystal which vibrates with its natural frequency.

The principle of crystal oscillator is piezo electric effect.

Piezo Electric Effect.

When a mechanical force is applied at the surface of certain crystals such as quartz or Roschelle salt, a potential difference will develop at the opposite face of the crystal. This phenomenon is called piezo electric effect.

The circuit diagram of a crystal oscillator is shown below.



The experiment can be done by using oscillator kit.

5.

Ultra Sound Scan

Ultrasound scan is a painless test that uses sound waves to create images of organs and structures inside your body. It is a very commonly used test. Ultrasound is a high-frequency sound that you cannot hear but it can be emitted and detected by special machines. An ultrasound scan, also referred to as a sonogram. Ultrasound scans are used to detect problems in the liver, heart, kidney or the abdomen. They may also be useful in helping the surgeon when carrying out some types of biopsies.

Principle

Ultrasound travels freely through fluid and soft tissues. However, ultrasound bounces back (is reflected back) as echoes when it hits a more solid (dense) surface. For example, the ultrasound will travel freely though blood in a heart chamber. But, when it hits a solid valve, a lot of the ultrasound echoes back. It is recorded and the image is formed.

This is a type of scanning in which sound waves of 2 to 20 MHZ are used. A transducer is used for delivering the ultra sound energy to the patient. The vibrating part of the transducer is called crystal.

What is an ultrasound test used for?

It is used in many situations. The way the ultrasound bounces back from different tissues can help to determine the size, shape and consistency of organs, structures and abnormalities. So, it can:

- Help to monitor the growth of an unborn child and check for abnormalities. An ultrasound scan is routine for pregnant women.
- Detect abnormalities of heart structures such as the heart valves. This type of ultrasound scan is called echocardiography. See the separate leaflet called Echocardiogram for more details.

Help to diagnose problems of internal organs such as the:

- Liver
- Gallbladder
- Pancreas
- Thyroid gland
- Lymph nodes
- Ovaries
- Testes
- Kidneys
- Bladder
- Appendix
- For example, it can help to determine if an abnormal lump in one of these organs is a solid tumour or a fluid-filled cyst. Ultrasound also helps look for

stones in the gallbladder or kidney.

- Help determine the nature of breast lumps. Ultrasound is one of the tests used to establish if a lump is non-cancerous (benign) or breast cancer.
- Help diagnose problems with muscles, tendons and joints. For example, ultrasound scans are used to help diagnose:
- Frozen shoulder
- Tennis elbow
- Morton's neuroma
- Carpal tunnel syndrome
- Detect abnormal widening of blood vessels (aneurysms).
- Guide internal biopsies. A biopsy is a procedure in which a sample of tissue is taken. Some biopsies are taken using a thin needle, and the needle is guided to the right place with an ultrasound scan. For example, if you have a lump in your breast, you may have a sample of the lump taken away. The sample is then examined under the microscope to see if your lump is cancerous or not.

Some specialist ultrasound techniques

In some situations, a clearer picture can be obtained from a probe that is within the body. So a small probe, still attached by a wire to the ultrasound machine, can be:

- Swallowed into the gullet (oesophagus). This may be used to obtain clearer images of the internal organs, particularly the stomach, upper gut and pancreas. See separate leaflet called Endoscopic Ultrasound Scan for more details.
- Placed in the vagina or rectum to obtain clearer images of inner organs, such as the womb (uterus), ovaries or prostate gland.
- Used to help guide a surgeon during an operation, in order to look deeper into structures.

Ultrasound may also be used for treating certain conditions, particularly those of muscles, tendons and joints. The scan may be used to guide an injection which can help to treat the problem. Doing the injection with the help of an ultrasound scan makes sure it reaches exactly the right place. For example, ultrasound-guided injections are a common way to treat shoulder problems such as a frozen shoulder.

Ultrasonography and Modern Equipment in Medical Imaging

1. Oscillators- fabrication of crystal oscillator by using kit.
2. CT and MRI scan - collection of pictures and preparation of album.
3. Other medical imaging equipment- Preparation of e-album.

TE QUESTIONS

1. Explain the working of crystal oscillator
2. What is the frequency of ultrasonic waves.
3. List out the medical application of ultrasonography.
4. Modern Imaging

Unit 3 - Modern equipment in imaging

4.3.1 To familiarise CT scanning.

4.3.2 To familiarise MRI scanning.

4.3.3 Identify modern imaging techniques- names only

5. Applications of PET, SPECT, gamma camera.

CT scan

CT scan is a modern imaging technique in which the images are formed by using X rays. CT stands for Computed Tomography or Computer Tomography.

Principle

In this method X rays are transmitted throughout the body and a multidirectional scanning of the patient is done. From this multiple data are collected. Then computer performs some calculations and obtain necessary information. Finally a two dimensional picture called slice is obtained.

A calculation based on the data obtained from the scan is made by the computer. The output unit then produces a visual image of the patient.

A typical CT Scan machine

Scan Artifacts

There are many sources of errors which can produce artifacts during recording. They are

1. Noise
2. Motion artifacts

3. Artifacts due to high differential absorption in adjacent tissues.

4. Technical errors and computer artifacts.

Applications

CT is now an investigative procedure which is more clear than X ray. It detects bone injuries, of

CT is helpful in detecting arteriovenous malformations like angiomas before its rupture.

CT is helpful in the treatment of cancer.

MRI Scanning

This imaging technique uses the RF region of the electromagnetic spectra for producing an image.

MRI stands for Magnetic Resonance Imaging. Here the patient is placed in a magnetic field which causes the magnetization of the protons of the hydrogen atoms in the body. Now a radio frequency pulse at resonance frequency is transmitted into the patient under controlled conditions. As a result a nuclear magnetic resonance signal is produced. These signals during their return from higher nuclear energy level to ground state are processed by the computer to produce an image.

Figure of a MRI Scanning machine

MRI has the following advantages.

1. Absence of harmful radiations like X rays, gamma rays etc.

2. Superior resolution and contrast

3. Direct multi planar imaging.

Modern Imaging Techniques

PET

A positron emission tomography (PET) scan is an imaging test that allows your doctor to check for diseases in your body.

The scan uses a special dye that has radioactive tracers. These tracers are injected into a vein in your arm. Your organs and tissues then absorb the tracer. When highlighted under a PET scanner, the tracers help your doctor to see how well your organs and tissues are working. The PET scan can measure blood flow, oxygen use, glucose metabolism (how your body uses sugar), and much more.

A PET scan is typically an outpatient procedure. This means you can go about your day after the test is finished.

SPECT

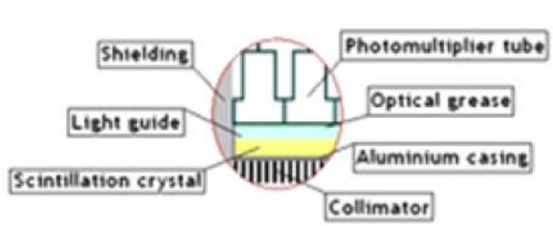
Single-photon emission computed tomography (SPECT) is a nuclear medicine tomographic imaging technique using gamma rays.[1] It is very similar to conventional nuclear medicine planar imaging using a gamma camera.[2]However, it is able to provide true 3D information. This information is typically presented as cross-sectional slices through the patient, but can be freely reformatted or manipulated as required.

The technique requires delivery of a gamma-emitting radioisotope (a radionuclide) into the patient, normally through injection into the bloodstream. On occasion, the radioisotope is a simple soluble dissolved ion, such as an isotope of gallium(III). Most of the time, though, a marker radioisotope is attached to a specific ligand to create a radioligand, whose properties bind it to certain types of tissues.

Gamma Camera

A gamma camera, also called a scintillation camera or Anger camera, is a device used to image gamma radiation emitting radioisotopes, a technique known as scintigraphy. The applications of scintigraphy include early drug development and nuclear medical imaging to view and analyse images of the human body or the distribution of medically injected, inhaled, or ingested radionuclides emittinggamma rays.

Construction



A gamma camera consists of one or more flat crystal planes (or detectors) optically coupled to an array of photomultiplier tubes in an assembly known as a "head", mounted on a gantry. The gantry is connected to a computer system that both controls the operation of the camera as well as acquisition and storage of acquired images. The construction of a gamma camera is sometimes known as a compartmental radiation construction.

Modern Equipment in Medical Imaging

1. The rays used in CT scanner is ------------.
2. Expand CT and MRI
3. Name the parts of CT scanner.
4. What is the basic principle of MRI .
5. Write short note on MRI Scanner
6. Expand PET and give its applications.

UNIT 4

PATIENT SAFETY

Unit 4 - Patient safety

4.4.1 To familiarize the importance of general safety in hospitals.

4.4.2 To understand the effects of electricity in human body.

4.4.3 To understand electric shock hazards and precautions to avoid shock..

4.4.4 To understand IEC documents and safety codes.

4.4.5 To understand the grounding in Biomedical Equipment.

4.4.6 Familiarise rules and ethics in medical field.

Importance of General Safety In Hospital

The chance to electric shock is associated with all the instruments and machines operating with electric current. The medical instruments also is not an exemption form it. But the situations where these are operated are entirely different from others. The result of an electric shock from these instruments will be more serious and fatal them others, since the patients lacking in resistive power subjected to it. The patients subjected to the electric shock in this case is more exposed to electricity than others. Electrical shock may cause an unwanted cellular depolarization's and its associated muscle contraction or it may cause cell vaporization and tissue injury.

There for it is very important to design the medical instruments and equipment very carefully to eliminate the chance of an electric shock. The equipment in the hospital must be organized properly and up to the safety regulations and standards as prescribed by the manufactures besides this a variety. A safety instruments are now available in the market which help to ensure maximum safety for the patients and the staff operating with different medical equipments in hospitals.

Effect of electric current on Human Body

The passage of electric current through our body can produce different responses depending upon the magnitude of the electric current. Small amount of current will produce only a tingling or slightly painful effect where as larger currents can produce cell depolarization's and muscle contraction, cell vaporization and tissue burns and even respiratory paralysis and death. The amount of current entering the body is determined by various factors like the smoothness of the skin, moisture present on the skin, the age of the patient and even the sex.

Effect of various levels of current on the Human Body

Current	**Effect**
1 Milliampere	Tingling sensations, threshold of perception
5 Millampere	Slight shock felt, not painful but disturbing
6 to 20 MA	Painful shock, let go range
50 MA	Extreme pain, respiratory arrest severe muscular contraction
100 MA	Ventricular fibrillation
5A	Possible burns, sustained myocardial contraction, respiratory paralysis and probable death.

Classify the shock hazards associated with electric current in to two types.

1. Micro Shock
2. Macro or gross shock

Micro Shock

Micro Shock is the physical response to a current applied to the surface of the heart that produces undesired stimulation, muscle contraction and tissue injury. In this case the current instead of being applied to the skin surface with high impendence is by passed to the heart directly through highly conductive liquid column. This occurs in the case of patients in the coronary care unit. The most dangerous situations encountered during a micro shock is the ventricular fibrillation.

Macro Shock

The gross shock or macro shock is experienced by the subject due to an accidental contract with a live electric wire at any part of the body on its surface. It may be defined as the physiological response to an electric current applied on the surface of the body that can create undesired stimulations, muscle contraction and tissue injury. The amount of current required to generated a physical response differs from persons to persons depending upon the skin resistance.

Threshold of Perception

The threshold of perception of electric shock is about 1 mA. At this level, a tingling sensation is felt by the subject when there is a contract with an electrified object through the intact skin.

Let - go Current

The maximum level of current that can be tolerated by a person without experiencing muscle condition is called let - go current. Let go current for males was 16mA and for females was 10.5 mA. When the current becomes greater than the let-go level, the person looses control over his muscle movements and is not able to release his grip from the current carrying conductor. This level of current is called the hold on type current.

Precautions to avoid shock

1. Ensure proper grounding for all the instruments used is connection with the patient use only power cords with three wires.
2. Provide isolated input circuits on monitoring equipment.
3. Ensure strict regular listing of the ground
4. The mechanical construction of the instruments or apparatus must be smooth and compact to avoid the chance of injury to the operator or patient.

5. Staff should be properly trained to operate the instruments.
6. The functional controls should be legibily marked at the front panel of the instruments.
7. The operating instructions should be clear and must be permanently displayed at the front. It should be regarded as part of the instrument.
8. Adapter plugs are used in connection with certain portable instruments. Since they doesn't ensure proper grounding special care my be taken against micro shock.
9. No other apparatus should be used near a patient monitoring equipment.
10. Connectors for the probe and the patient lead must be standardized.
11. A voltage in excess of 5mv should exist between the instrument ground outlet and any other ground points or conductive surfaces in the area.

Safety Codes for Electro Medical Equipment

The problem of ensuring a safe environment for the patients as well as for the operators has been engaging the attention of all concerned in several countries at the national and international levels. Various countries have laid down codes of practice for equipment intended to be used in hospitals. The International Electro technical Commission (IEC) comprising of representatives of various countries had laid down a document, IEC 601 specifying the Universal standards for manufactures of Electro medical equipment and regarding the hospital safety. Based on this Indian standard Institutions (ISI) has also issued a national level standards IS 8607 dealing with standards and regulation for general safty requirements of electro medical equipments IS 8607 cover the following topics in different parts:

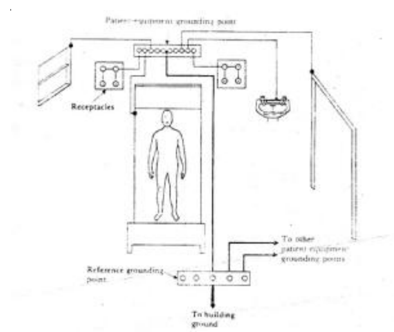
1. General
2. Protection from electrical hazards
3. Protection from mechanical hazards.
4. Protection from undesired and harmful radiations
5. Protection from explosion
6. Protection from excessive hear, fire…. Etc.
7. Construction of the equipment.

8. Behaviour and reliability

Individual standards are specified for some of the important medical instrument such as IS 8048 for electro cardiograph, IS 7620 for X-ray unit, IS 8885 for electromyograph and IS 9286 for cardic defibrillators.

Grounding in Biomedical Equipment

Low resistance ground that can carry currents up to circuit-breaker ratings are clearly essential for protecting against both macroshock and microshock, even an isolated power system is used. A grounding system is used. A grounding system protects patients by keeping all conductive surfaces and receptacle grounds the patient's environment at the same potential. It also protects the patient from ground faults at other location.



The grounding system has a patient equipment grounding point, a reference grounding point, and connections , as shown in figure the patient equipment grounding point is connect individually to all receptacle grounds, metal beds, metal door and window frames, water pipes, and any other conductive surfaces.

These connections should not exceed 0.15Ohm. The difference in potential between receptacle grounds and conductive surface should not exceed 40mV. Each patient equipment grounding point must be connected individually to a reference grounding point that is in turn connected to the building service ground.

Patient Safety

1. Precautions to avoid electric shock and safety codes - Chart preparati

TE Questions

1. Distinguish between microshock and macroshock.
2. Write down the precautions that has to be taken in a hospital to avoid electric shock from bio medical instruments.
3. IS 8607 is safety code. Indentify where this code is used?
4. Let go current for men is____________________

5. Micro shocks may occur

   a) Due to flow of 1A current flow across the body surface

   b) Due to 5amp current flow across the body for 1 minute.

   c) Due to shortening of electrical leads in the pacemaker.

   d) Due to flow of few mA current a cross the cardiac muscles.

6. Let to current are

   a) Same for men and women

   b) Same for all frequencies

   c) Higher for men than women

   d) Higher for persons having enormous weight.

Medical ethics

Medical ethics is a system of moral principles that apply values and judgments to the practice of medicine. As a scholarly discipline, medical ethics encompasses its practical application in clinical settings as well as work on its history, philosophy, and sociology.

A common framework used in the analysis of medical ethics is the "four principles" approach postulated by Tom Beauchamp and James Childress in their textbook Principles of biomedical ethics. It recognizes four basic moral principles, which are to be judged and weighed against each other, with attention given to the scope of their application. The four principles are:[7]

- Respect for autonomy - the patient has the right to refuse or choose their treatment. (Voluntas aegroti suprema lex.)
- Beneficence - a practitioner should act in the best interest of the patient. (Salus aegroti suprema lex.) The term beneficence refers to actions that promote the well being of others. In the medical context, this means taking actions that serve the best interests of patients. However, uncertainty surrounds the precise definition of which practices do in fact help patients.
- Non-maleficence - "first, do no harm" (primum non nocere). he concept of non-maleficence is embodied by the phrase, "first, do no harm," or the Latin, primum non nocere. Many consider that should be the main or primary consideration (hence primum): that it is more important not to harm your patient, than to do them good. This is partly because enthusiastic practitioners are prone to using treatments that they believe will do good, without first having evaluated them adequately to ensure they do no (or only acceptable levels of) harm. Much harm has been done to patients as a result, as in the saying, "The treatment was a success, but the patient died." It is not only more important to do no harm than to do good; it is also important to know how likely it is that your treatment will harm a patient. So a physician should go further than not prescribing medications they know to be harmful - he or she should not prescribe medications (or otherwise treat the patient) unless s/he knows that the treatment is unlikely to be harmful; or at the very least, that patient understands the risks and benefits, and that the likely benefits outweigh the likely risks.
- Justice - concerns the distribution of scarce health resources, and the decision of who gets what treatment (fairness and equality). (Iustitia.)

Other values that are sometimes discussed include:

- Respect for persons - the patient (and the person treating the patient) have the right to be treated with dignity.
- Truthfulness and honesty - the concept of informed consent has increased in importance since the historical events of the Doctors' Trial of the Nuremberg trials andTuskegee syphilis experiment.

he principle of autonomy views the rights of an individual to self-determination. This is rooted in society's respect for individuals' ability to make informed decisions about personal matters. Autonomy has become more important as social values have shifted to define medical quality in terms of outcomes that are important to the patient rather than medical professionals. The increasing importance of autonomy can be seen as a social reaction to a "paternalistic" tradition within healthcare.[citation needed] Some have questioned whether the backlash against historically excessive paternalism in favor of patient autonomy has inhibited the proper use of soft paternalism to the detriment of outcomes for some patients. Respect for autonomy is the basis for informed consent and advance directives.

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