

# EQUIPMENT MAINTENANCE SOURCE:

WHO MEDICAL DEVICE TECHNICAL SERIES

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# WHY EQUIPMENT MAINTENANCE

- Era of cost intensive Medicare
- Demand for improved diagnostic facilities
- Sophisticated equipment with modern technology
- Spectacular progress in development in surgical procedures
- Physicians are becoming more investigation oriented
- Patients expecting high quality care
- Introduction of computer technology and Robotics in medical field
- Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation
- Medical devices are assets that directly affect human lives.
- They are considerable costly investments
- Equipment maintenance programme keep the medical equipment in a reliable, safe and available for use when it is needed
- Such a programme prolongs the useful life of the equipment and cost effective

# OBJECTIVE OF MAINTENANCE

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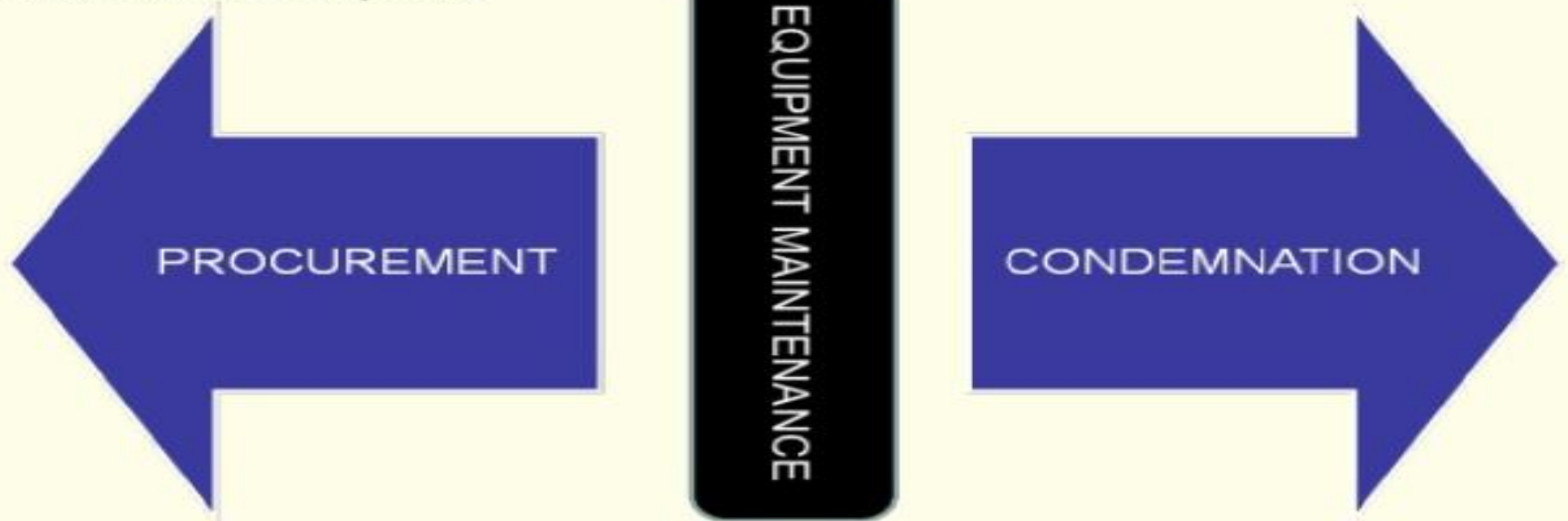
- To optimize utilization to obtain maximum return for capital invested
- Cost efficiency/cost effectiveness
- Better utilization results in quick 'Break-even point'
- Optimal patient handling and rapid turn over minimises cost
- Quality patient care and satisfaction
- Patient as well as user Safety

# SCOPE OF MAINTENANCE

1. Planning and implementation of a program of planned preventive maintenance in r/o all the facilities / services under the irresponsibility.
2. Ensuring that all the facilities, systems and services under the scope of engineering services are well maintained and kept in a state of optimum operational efficiency.
3. Maintaining an up-to-date inventory of all the equipment available and their distribution on the hospital.
4. Maintaining an up-to-date history sheet for each and every /equipment unit in the hospital.
5. Anticipating the requirement of commonly required spares and arranging for their adequate stocking.
6. Ensuring that break down maintenance is prompt enough to ensure uninterrupted services. This, however, does not include sophisticated / electronic equipment that should be better handled under the arrangement by suppliers.
7. Ensuring that the facilities / services coming under their scope are safe and hazard free.

# EQUIPMENT MAINTENANCE PROGRAM

Equipment maintenance program starts from Procurement and ends at Condemnation and disposal



# EQUIPMENT MANAGEMENT SYSTEM

1. Organisation
2. Inventory
3. Selection and acquisition
4. Installation
5. Calibration/validation( initial and on going)
6. Maintenance
7. Trouble suiting
8. Service and repair
9. Computer soft ware
10. Condemnation and disposal



# EQUIPMENT SELECTION CRITERIA

- Need assessment
- Use co-efficient
- Specifications not brand
- CIF destination
- Installation on turn key basis
- Warranty with spares
- Continuous supply of consumables
- Service contracts/ after sales services
- Training of staff
- Preparation/selection of site
- Power supply back up
- Good economics
- Supplies selection and purchase procedures





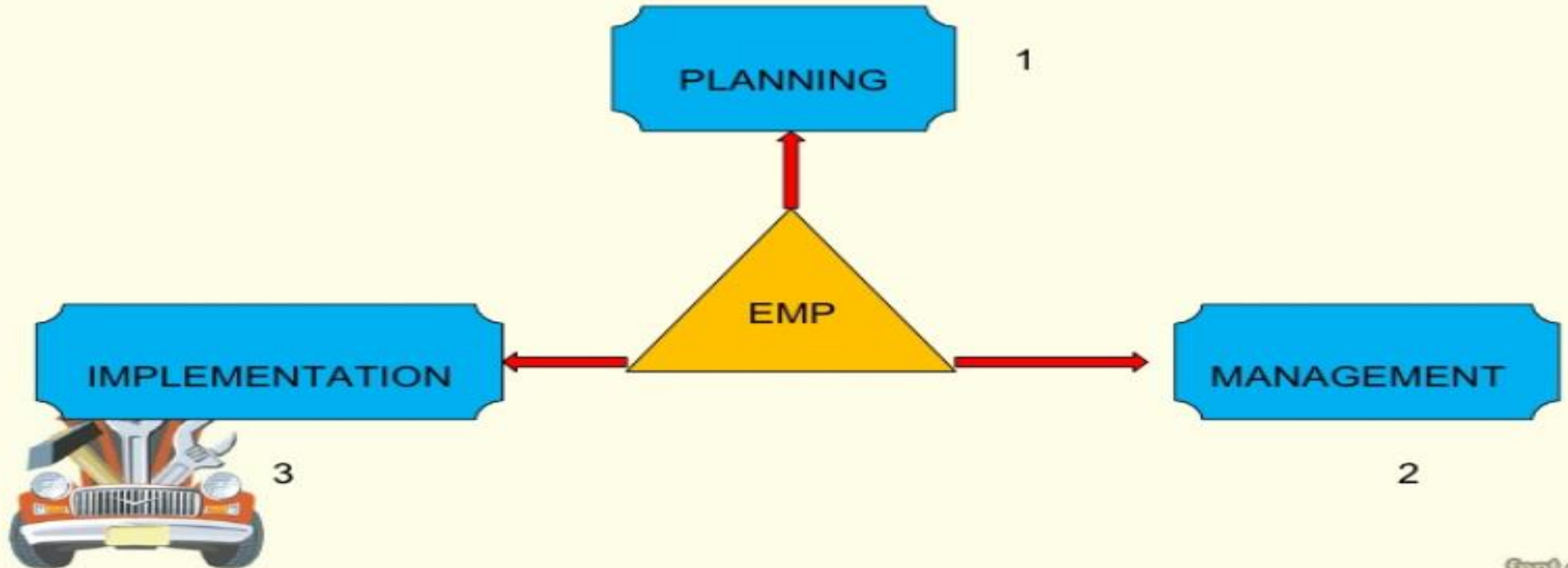
# COMPONENTS OF A MAINTENANCE PROGRAMME





# EQUIPMENT MAINTENANCE PROGRAMME

An effective medical equipment maintenance programme consists of :-



## **Planning**

It considers the financial, physical and human resources required to adequately implement the maintenance activities.

## **Management**

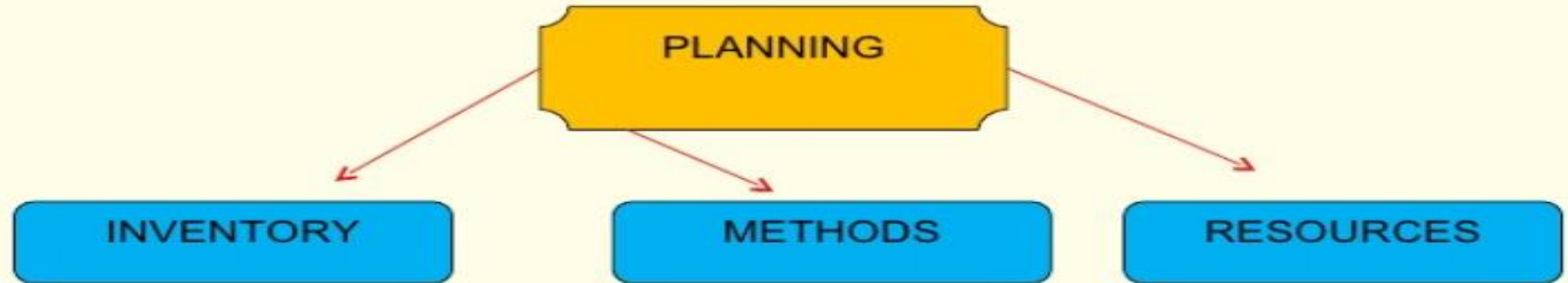
Once the programme has been defined, financial, personnel and operational aspects are continually examined and managed to ensure the programme continues uninterrupted and improves as necessary.

## **Implementation**

Ultimately, proper implementation of the programme is key to ensuring optimal equipment functionality.



# PLANNING



Equipments to be include in the maintenance programme.



- i) Contracts with device manufacturers,
- ii) Independent service organizations(ISOs),
- iii) A combination of both.

- i)Financial resources
- ii)Manpower resources
- iii)Physical resources



# 1.FINANCIAL RESOURCES

	INITIAL COSTS	OPERATING COSTS
Physical resources	Space, tools, test equipment, computer resources, vehicles.	Operation, utilities, maintenance, calibration.
Human resources	Recruiting, initial training.	Salaries, benefits, turnover, continuing education.
Direct maintenance	NA	Service contracts, parts and materials, travel, shipping.



## 2. PHYSICAL RESOURCES

### 1) WORKSPACE

- It includes work benches and storage space for tools and test equipment, repair parts and supplies, and equipment awaiting repair.
- It also includes space for records and documentation, service and operator manuals, and access to whatever computer resources are required.
- Inclusion of computer resources in the workspace is also important to consider.
- Basic documentation may be maintained with paper records
- The use of a computer spreadsheet, database programme, or computerized maintenance management system (CMMS)





## **II) TOOLS AND TEST EQUIPMENT**

- Investment in tools and test equipment results in reduced maintenance costs.
- Increase the reliability of the readings, the accuracy of the calibrations, and the margin of safety for the patients and staff,
- Basic test equipment includes a physiological simulator, safety analyser and some basic tools.

## **III) SUPPLIES**

- Cleaning and lubricating supplies, need to be acquired in sufficient quantities.
- The manufacturers' service manuals give cautions about using the wrong cleaning agents, which can damage labeling and the plastic surfaces of some equipment.



#### **IV) SPARE PARTS**

- Some times, it may be possible to forecast in advance what parts need to be replaced and how often.
- By referring to the manufacturer's guidelines, the problem of obtaining replacement parts at a reasonable cost and in a timely manner can be possible

#### **V) OPERATION AND SERVICE MANUALS**

- Ideally, the maintenance programme will have an operation (user) manual and a service manual for each model of medical equipment.
- For donated equipment, when manuals have not been provided and due to the age or type of equipment are impossible to access, the experience of the staff will be the primary resource.





# 3 HUMAN RESOURCES

PERSONNEL	SPECIALITY	FUNCTION
Engineer	Biomedical engineer or clinical engineer Other related fields (e.g. electrical engineer, mechanical engineer)	Management, specialized maintenance, supervision of external service provider, needs assessment, planning, and user training.
Technician	Biomedical equipment technicians Other related fields (e.g. electrical or medical technologist, polyvalent technician)	Primary focus on specialized medical equipment repair and maintenance. Preventive maintenance and repair of less complex equipment. It is important that they receive specialized training for high-risk medical devices.
Service provider	Engineer or technician	Provide maintenance that cannot be performed in house. They are product-oriented and specialized in a certain field.
Engineering management staff	MBA/PGDMA	Provide leadership for the maintenance programme



# MANAGEMENT





## 1.FINANCIAL MANAGEMENT

Financial management for a maintenance programme focuses primarily on two tasks:

- i) **Monitoring costs**
- ii) **Managing the budget.**

Costs are monitored by accurately documenting all of the time and expenses associated with maintenance activities.

## **2.PERSONNEL MANAGEMENT**

- i) The purpose of personnel management is to **provide support** to the maintenance programme's human resources so that programme objectives are achieved.
- ii) Work assignments should be made to **match the skills** of the technical personnel and to promote efficiency.

### **A. SERVICE VENDORS**

It is often not possible to provide all maintenance services in house. In such circumstances, it may be necessary to make use of external service providers for a significant portion of the maintenance activities.

There are generally two categories of external service providers:

- i) **Equipment manufacturers**
- ii) **Independent service organizations**



## B.SERVICE CONTRACT

TYPE OF SERVICE	FREQUENCY	COST
AMC	Internal staff provides initial response. External staff follows up as and when required. At least four visits a year	Fixed charge Only service provided Renewed every year
CMC	Varying response time available as needed	CMC charges Service, minor spares and consumables free
Full service with parts (WARRANTY) 5 to 10 years	Quick response available at all times for maintenance and repair	Fixed Charge Parts to be provided on payment





## C. TRAINING

For the safety of the patient and the user, proper training is critical for both the user and the technical staff.

- **Self-study:**

- reading the equipment service and training manuals;
- using additional self-study materials provided by the manufacturer;
- using materials provided by a third party.

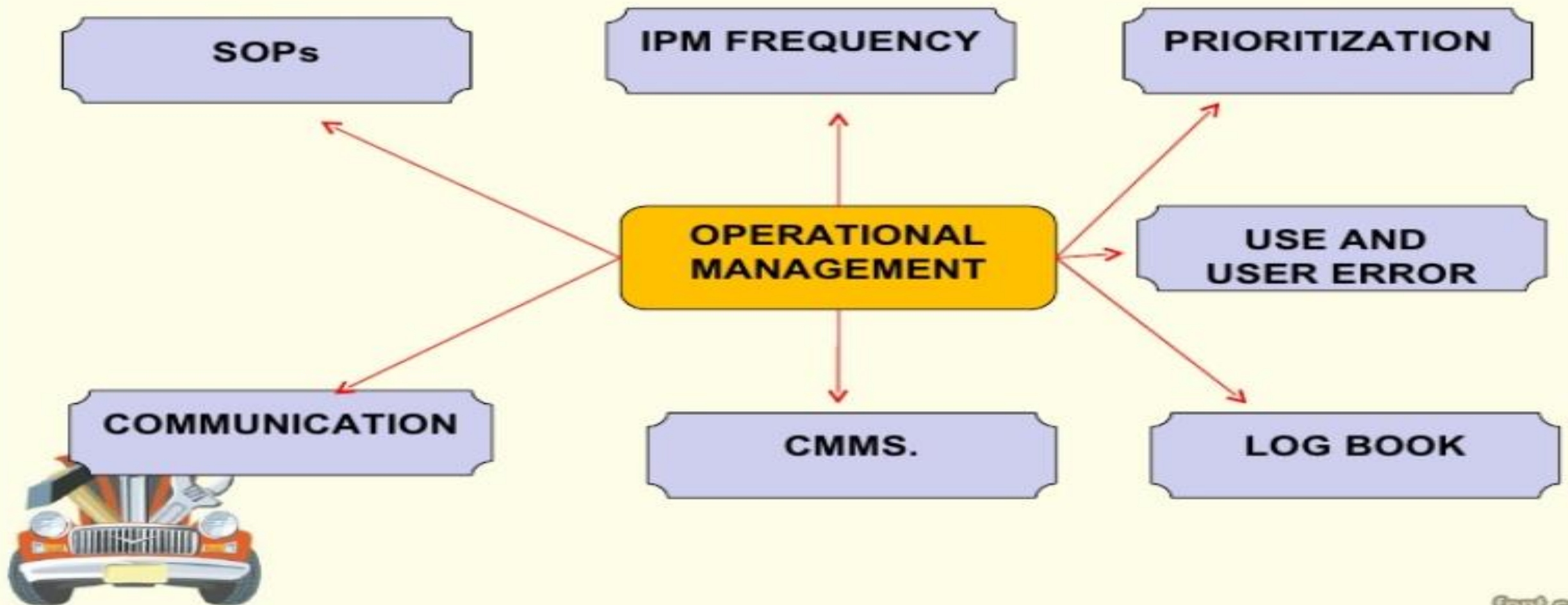
- ***One-to-one training*** provided by a more experienced person from inside the organization

- **Manufacturer's training** programs

- specifically designed for equipment technicians and provided by the Indian agent.



### 3. OPERATIONAL MANAGEMENT



# 3. OPERATIONAL MANAGEMENT

## 1. SOPs

Procedures are either selected or written

- Be well designed and easy to understand.
- Clearly explain every step in the procedure.
- Explain what test equipment is required.
- Explain what the upper and lower limits for measurements the biomedical equipment technician will take.
- Show how to replace parts.
- Explain the required frequency of specific steps.
- Provide recommended forms to be used for the IPM procedure.
- Be provided in the predominant major language of the region/country.





## **2.Setting IPM frequency**

- The frequency of IPM is specified by the manufacturer of the equipment
- Period should be specified like Daily, Weekly, Monthly, Quarterly or Annually.

## **3.Prioritization of work**

- It is better to carefully identify the equipment in the health-care facility that is the most important to inspect and maintain, and schedule this work as a priority.

## **4.Keeping records( Log book)**

- Identification number for the equipment
- The record for each device should include identifying data such as a brief description, manufacturer, model, serial number,
- Installation site, date of procurement and cost
- Data regarding the time and expense of providing scheduled and unscheduled maintenance services for the device and cost incurred.
- Cumulative expenditure on maintenance and repair.



## 3. OPERATIONAL MANAGEMENT

### 5. CMMS.

Thus, a computerized maintenance management system (CMMS) helps by:-

- Keep track of past service events (e.g. IPM, CM, recalls, software updates etc.) and retrieve or print them if needed.
- Store IPM procedures and related information.
- Schedule IPM procedures, change the schedule of IPM procedures and print a summary list of what has been scheduled.





# CMMS

- Print individual IPM forms with the appropriate procedure, the past few service events (for reference), and the expected IPM completion date/ time.
- Record and store the results of the IPM inspection procedures including tasks that passed or failed, the measurements taken and the acceptable range of measured values.
- Record the CM activity including the problem with the device, time spent in the repair process, a description of the work done and the list of parts used.



## **Produce summary reports of:**

- i).IPM completion rates;
- ii)IPM that failed and required repair work;
- iii) IPM actual versus expected completion times;
- iv) Inventory lists of equipment by 30 Medical equipment maintenance programme overview location, owner or device type;
- v)Repairs completed in a certain time period;
- vi) List of parts used to repair equipment over a certain time period.





## **6.Communication**

The ultimate objective of a maintenance programme is to improve patient care, there fore,

- iii)It is essential to develop strong working relationships with clinicians and to understand their needs
- iv)Take maintenance work according to their convenience.
- v)Send schedule of maintenance well in advance to departments.

## **7.Managing use and user error**

A user may be unable to meet this objective due to 'use error', a problem related to the use of a medical device which may be

- fault in the machine
- users incompetence.

The root cause of user error to be identified and corrected.



## 4.PERFORMANCE MONITORING

### 1.Performance measures

- Mean time between failures. The average time elapsed between failures.
- Repeated failures. The number of failures within a specified period of time.

Response time. The time between a request for service and the start of repair.

- Repair time. The time between the start and finish of repair.
- Downtime. The percentage of time that a device is out of service.
- Delinquent work orders. Work orders not completed within 30 days





# 5. IMPLEMENTATION

## A. Inspection and preventive maintenance

- Most IPM procedures are completed by technical personnel from the clinical engineering department.
- In some cases, however, routine and easy to perform tasks are completed by the user.
- The type of inspection the user might perform would be pre-use or daily checks, where required.
- Examples of this might be daily calibration of portable blood glucose monitors, daily testing of defibrillators or checking the standard calibration of laboratory equipment.
- If the IPM activities or related repairs are not accomplished in a certain pre-defined period, by the **authorised agent** the work order should be left open and the staff should inspect or repair the device as soon as reasonably possible.





## **B. Corrective maintenance**

i). Component level. Component-level troubleshooting and repair isolates

the failure to a single, replaceable component. In electrical devices,

mechanical devices, and for discreet Board level.

ii). For electronic devices, it is common to isolate failures to a particular circuit board and to replace the entire circuit board rather than a given electronic component.

iii). Device or system level. In some cases even board-level troubleshooting and repair is too difficult or time consuming.

iv) In such cases it can be more cost-effective to replace the entire device or subsystem.



### **C. Environmental factors**

- i). Electricity failure, short circuit, high voltage
- ii) AC failure
- iii) Inadequate water supply.

### **D. Reporting**

- i). For IPM activities, the technician typically has a detailed checklist to follow in order to record the results.
- ii). Having such a checklist also serves as a reminder of each step in the IPM process and thus helps avoid skipping or overlooking specific steps.





## **E. Safety**

➤ There are various safety aspects to consider when implementing a successful and effective maintenance programme,

iii) The safety of technical personnel while performing maintenance,

iv) Safety of the user following maintenance,

v) Safety of the Patient

vi) Infection spread.

➤ It is preferable to have PPE readily available within the clinical engineering department for hazardous maintenance.

➤ Lastly, when working in the clinical environment, technical personnel should be aware of infection control risks that they might encounter.



# CONSTRAINTS IN MANAGEMENT

- ❖ Inadequate training of staff
- ❖ Equipment installed on turn key basis so that staff can not do preventive maintenance
- ❖ After sales services by supplier is not satisfactory
- ❖ Facility for back up power supply some times inadequate
- ❖ Time scheduling of the hospital prevent 24x7 utilization of equipment
- ❖ Poor Use co-efficient
- ❖ Awareness of the facility to patients sometimes lacking
- ❖ Utilization of the special facility or skill requires staff motivation and cost to the patient





# CONSEQUENCES OF POOR MAINTENANCE

- ❑ Only 50%-60% of equipment are in usable condition survey done by DOE (Deptt. Of Exp.)-in Delhi.
- ❑ High tech equipment worth Rs 50 crore are lying idle in government hospitals in Delhi.
- ❑ Common factors contributing for wastage
  - ✂ Purchase of equipment which is never used due to lack of technical expertise to maintain and use it.
  - ✂ Reduce lifetime due to mishandling and lack of maintenance and repair.
  - ✂ Non-availability of spares, accessories.
  - ✂ Excessive downtime due to lack of preventive maintenance
  - ✂ Change of Indian Agent.



# CONDEMNATION

- ❖ Completed Life time( 7 to 10 years) Electronic equipments.
- ❖ Beyond economic repair (BER)
- ❖ Non functional and obsolete
- ❖ Functional and obsolete
- ❖ Functional but hazardous
- ❖ Procedure/ documents required for condemnation
  1. History sheet
  2. Recommendation of Maintenance Committee.
  3. Condemnation committee recommendation to HOD.
  4. Approval of competent authority for disposal and right off.

