

OPHTHALMIC INSTRUMENTS AND EQUIPMENT

A handbook on
Care and
Maintenance
(SECOND EDITION)

V. Srinivasan
R. D. Thulasiraj

laico
LIONS ARAVIND INSTITUTE OF
COMMUNITY OPHTHALMOLOGY



Ophthalmic Instruments and Equipment

- A handbook on care and maintenance
(Second Edition)

V. Srinivasan

Professor of Physics
Consultant, Instruments Maintenance Laboratory

R.D. Thulasiraj

Executive Director
Lions Aravind Institute of Community Ophthalmology

laico
LIONS ARAVIND INSTITUTE OF
COMMUNITY OPHTHALMOLOGY



A R A V I N D E Y E C A R E S Y S T E M

Edited and designed by : *Aravind Publications staff*

Published by : *Aravind Eye Hospital
& Postgraduate Institute of Ophthalmology
Madurai, India*

Printed at : *Sri Aurobindo Ashram Press
36, Goubert Avenue, Pondicherry 605 002, India*

*First Edition, 1997
Second Edition, 2003*

LIONS ARAVIND INSTITUTE OF COMMUNITY OPHTHALMOLOGY
& Postgraduate Institute of Ophthalmology

*1, Anna Nagar, Madurai - 625 020, Tamil Nadu, India
Phone: 91-452-535 6100, Fax: 91-452-253 0984
www.aravind.org*

Dedication

*This hand book is dedicated to
Padmashri Dr. G. Venkataswamy and
others like him who have dedicated their
lives for the eradication of curable
blindness.*

Contents

DEDICATION	III
PREFACE TO THE SECOND EDITION	VII
PREFACE TO THE FIRST EDITION	IX
INTRODUCTION	1

SECTION I

1. GENERAL PRINCIPLES OF MAINTENANCE AND TERMINOLOGY	3
2. COMMON MAINTENANCE TASKS AND TECHNIQUES TO HANDLE THEM	6
3. MAINTENANCE MANAGEMENT	11

SECTION II

4. TORCH LIGHT	17
5. OPHTHALMOSCOPE	19
6. RETINOSCOPE	24
7. INDIRECT OPHTHALMOSCOPE	27
8. SLIT LAMP	31
9. OTHER OPTICAL EQUIPMENT	37

SECTION III

10. GENERAL CARE OF SURGICAL INSTRUMENTS	40
11. CARE OF KNIVES	42

APPENDICES

I. MULTIMETER	43
II. OPTICAL SURFACES	45
III. SOME SIMPLE ELECTRICAL CALCULATIONS	46
IV. TRAINING COURSE	47
INDEX	49

Preface to the second edition

Ten thousand copies of the first edition were printed. A good number of them were distributed to various users by the sponsors - DANPCB. The remaining copies were sold out. There has been a persistent request to bring out a second edition. The revision was getting postponed for want of good free time needed for such works. Based on our experience in running nearly thirty instruments maintenance courses in the last seven years the book has been thoroughly revised and enlarged.

This edition was also processed at the Aravind Communications Centre at LAICO. We record our appreciation for the patient work done by Mrs. Chitra Thulasiraj, Mrs. M. Jeyalakshmi and Mrs. Sharmila Noor.

Madurai
September 2003

V. Srinivasan
R.D. Thulasiraj



Preface to the First edition

The quality and efficiency of medical service provided in any hospital depends very much on the proper functioning of the equipment and instruments used by the doctors and other clinical staff. Even under normal and careful use, instruments fail to function properly. The frequency of such failures can be considerably reduced by proper care, maintenance and timely repair.

Especially in ophthalmology, there has been a major increase in the use of sophisticated instruments and equipment during the last decade. This has led to a higher quality of eye care services, resulting in an increased demand for eye care services from the general public. But at the same time, this has created a higher dependency upon the proper functioning of such equipment. It has therefore become imperative to ensure that the necessary equipment is in an optimal condition. Hence this manual.

This manual is intended for ophthalmic units delivering secondary level eye care services. These units generally do not have special technical departments dealing with maintenance and repair of medical equipment. It is written for clinical and technical staff, normally dealing with maintenance and care of equipment and does not require any special training in engineering.

It is also intended for ophthalmologists and other clinical staff using these instruments and equipment. Not that ophthalmologists should become technicians, but as in health care, the rule “prevention is better and cheaper than cure” is also valid here. It is important that all junior staff is trained in the proper handling and care of each instrument, to know the optimal quality of its functioning and how to recognize any faults in time.

Ophthalmologists and their patients will benefit most from equipment that functions well and we do hope this manual will contribute to that.

This is our first attempt to bring out such a handbook. Not all the instruments used by ophthalmologists are included in it. In the instruments described, it is possible that some of the maintenance problems of users are not described. The users of the handbook are requested to send all their comments and suggestions to us for improvement. All suggestions incorporated in subsequent editions of the handbook will be suitably acknowledged.

The publication of this handbook is sponsored by DANPCB (Danish Assistance to the National Programme for Control of Blindness), New Delhi. We record our thanks to DANPCB and to Dr. Hans Limburg in particular for giving us this opportunity of

putting together some of our ideas and experiences in maintenance of ophthalmic instruments. We also thank Dr. Limburg for the editorial input.

Dr. G. Venkataswamy, our Chairman, is a source of inspiration for everything that goes on at Aravind Eye Hospitals. The constant help and encouragement received from him is gratefully acknowledged.

The book was processed in the Aravind Communications Centre of LAICO. The work done by Mr. R. Saravanan and Mr. K. Lakshmanan deserves a special mention. We wish to record our appreciation of Mrs. Chitra Thulasiraj's support in coordinating the DTP work and for the cover page design. The patient work of Mrs. J. Bharathy in putting together our manuscript initially deserves a special appreciation.

Madurai
June 1997

V. Srinivasan
R.D. Thulasiraj

Introduction

A maintenance manual for ophthalmic instruments and equipment has been a long felt need. Especially in the context of India and other developing countries that have poor service infrastructure, difficulties in communication and in accessing required spares. This manual is an attempt to meet this need and to serve as a reference manual in the field to assist the persons in-charge of maintenance.

How to Use this Book: A manual is a reference guide to carry out repairs and maintenance. However, the wide variations between manufacturers and models make it impossible to provide specific step by step guide for each and every equipment. Such an attempt will be quite futile given the rapid change of technology and introduction of new models. The detailed user level maintenance instructions for a specific equipment are usually provided in the owners manual supplied along with the equipment by the manufacturer. Thus the purpose of this manual is to supplement the manuals supplied with the equipment.

Some suppliers of equipments also supply service manuals on some guarantee that they would not be misused. These manuals are intended for their service personnel and give elaborate step by step trouble shooting and repair procedures. An attempt should be made to get such manuals for one's own use.

Organization: This book is divided into three sections followed by appendices. The first section deals with general principles of maintenance, maintenance procedures common to many instruments, minimum requirements for carrying out maintenance function, record keeping and maintenance management. The second section deals with care and maintenance of specific instruments and equipment. The third section deals with the maintenance of surgical instruments. The appendices give more information.

The user of this manual is advised to go through and understand the first section completely as that forms the basis for all maintenance activities. Some of the systems and procedures, that are suggested should be put in place if not in practice already. The second and third section should be studied in an applied fashion. For instance, the chapter on slit lamp should be studied with a slit lamp physically present and the suggested preventive maintenance should be carried out as a practical session.

STEPS THAT REQUIRE CAUTION, SPECIAL WARNINGS OR PRECAUTIONS ARE HIGHLIGHTED IN THIS COLOUR.

Instrument or equipment? A dictionary defines instrument as a tool. Hospitals are equipped (furnished) with a variety of tools. Tools may also be referred to as equipments. A surgical knife is a tool, so also a surgical microscope. Tools help in carrying out a task accurately and with ease. However, in common parlance in hospitals, a distinction is made between the two terms. Surgical knife, scissors, ophthalmoscope, etc. that are held in one's hand during usage are referred to as instruments while surgical microscope, slit lamp, operating table, surgeon's chair, etc. are referred to as equipment. We will follow this distinction in this manual.

Scope of the manual: The level of maintenance can vary from simple cleaning to sophisticated broad levels or even component level repairs in electronic instruments. It may involve replacement of components of optical instruments. Similarly, the range of instruments can vary from a simple surgical knife to a complex laser system. This manual neither covers the entire range of equipments nor the more sophisticated maintenance activities. The purpose of this manual is to assist the person with the maintenance responsibilities to carry out simple maintenance

tasks on instruments and equipment that are commonly present in secondary eye care hospitals. The manual will enable one to carry out preventive maintenance, troubleshoot and identify problems and carry out customer level maintenance.

Requisites of a maintenance person: Maintenance is a step by step process. Each person may evolve his own steps and it is always good to go through all the steps on all occasion. Short circuiting of any step should be avoided. Only proper tools should be used for each job. One could take calculated risk in carrying out an unfamiliar job. One should not be scared of making a mistake. Only those who do no work make no mistakes. However one should learn from such mistakes. No mistake of a kind should happen more than once in the career of a maintenance person. It will always help to keep a record of all maintenance work including details of mistakes made and how it was rectified. It is always good to teach others the various maintenance tasks. One would learn more while teaching others. A good maintenance job is always satisfying.

General: An instrument purchased from a well known manufacturer through a well known dealer will always work well. Suppliers of instruments usually give a free warranty for periods ranging from a few months to a couple of years. One should make good use of the instrument during the warranty period. Any failure due to faulty components or manufacturing defects will happen in the warranty time and efforts should be taken to rectify the same. If an instrument has given good service during the warranty period one can expect an equally good service in the following years.

AN INSTRUMENT REPAIRED IS AN INSTRUMENT GAINED.

Any instrument not in use but occupying much needed hospital space must be repaired and brought back to working condition or should be withdrawn from the hospital and suitably disposed off.

Section - I

CHAPTER - 1

General Principles of Maintenance & Terminology

Maintenance of equipment and instruments has to be an integral function of any activity that involves their use in any significant way. Maintenance management is a well evolved discipline and it is well recognized in the industry. However, in health care it is yet to gain the importance that it deserves. This is probably due to the history of medical practice where till recently there was very little dependence on instrumentation or equipment, either for diagnosis or for treatment. X-ray machine and laboratory microscope were the most sophisticated equipment. In the last two decades, there has been a tremendous increase in the body of knowledge and newer technologies that exploit this knowledge to provide better diagnosis and treatment.

Instrumentation: Ophthalmology is one of the fields where there has been a tremendous innovation and technological growth. There was a time, not too long ago, when a patient with a cataract was diagnosed at best with the help of a torch light. He/She was then operated and no sutures were applied. The patient was bilaterally bandaged and had to stay immobile in bed for about a month. The outcome was often left to God. We are now back to sutureless surgery. But there is a big difference. The process of diagnosis has gone beyond determining just the presence of lens opacities. A keratometer is used to measure the curvature of the cornea and the astigmatism. Based on this, the surgical strategy is planned on the site of the incision to reduce the astigmatism. An ultrasound scanner (A-Scan) is used to determine the length of the eye ball. This information, together with the keratometry values and the patient's visual needs are used to compute the power of the intraocular lens (IOL) to be implanted. An interferometer is available to predict the postoperative visual outcome. Microscopes with good coaxial illumination, diamond scalpels and microsurgical instruments are used to make a very small incision, precisely in the planned location. A foldable IOL is inserted through the small opening after emulsifying and removing the opacified lens using a Phacoemulsifier. No sutures are applied. The patient is allowed to go home immediately and return to normal work within few days with instructions to follow a few basic precautions. A slit lamp is used throughout the patient care process starting with the preoperative assessment to all postoperative follow-ups. The visual outcome is almost guaranteed. Lasers of various kinds are used for a variety of applications. All this has become possible through sophisticated instrumentation that is rapidly becoming common. This instrumentation is also quite expensive. Already slit lamps and operating microscopes are available at all district hospitals. However, the benefit of all this technology can reach the patient only if the instruments are all in good working condition. It is in this context that maintenance has become a critical function. The maintenance function is not just limited to maintaining and repairing equipment; effective functioning involves several roles as detailed below.

Ordering the right equipment: The maintenance function really starts at the time of ordering the equipment. Availability of spares, after sales service and the reliability of the equipment should be taken into account while ordering the sophisticated equipment. Supply of maintenance and service manuals, initial set of spares and an agreement on after sales service should form part of the purchase package. Rapid advancement in technology and consequent improvement in newer models of the same equipment is another factor to be taken into consideration.

Installation & Training: It is the supplier's responsibility to install the equipment, test it and train the users in its proper use and handling. They must also provide maintenance training and trouble shooting specific to that equipment. The first person to receive the training from the supplier should in turn train one or more persons in the hospital.

Electrical input: This is the time to check and ensure that electricity required for the equipment is available at the correct voltage. Equipment from North America work on 110V. In India and in most other countries of the world, the electricity is made available to consumers at 220V. In some of the equipment designed for 110V, there may be a provision to adapt the instrument to work on 220V. In such cases the rating of the fuse provided for safety of the instrument should be halved. For example, if for 110V the safety fuse is 500mA, then for 220V operation it should be changed to 250mA. When such a facility for changing the input voltage is not provided in the equipment, a 220 to 110V step down transformer dedicated for the equipment should be used. Under this condition the safety fuse is not to be changed as the equipment gets only its rated voltage through the step down transformer. In recent times a provision is made in some 110V equipment that automatically accepts 220V input without any modification. If in the location where the voltage is likely to go much above 240V it is safer to use the instruments in 110V mode with a 220-110V transformer.

DON'T SIMPLY REPLACE THE 110V PLUG (WITH FLAT PINS) WITH LOCALLY AVAILABLE 220V PLUG (WITH CYLINDRICAL PINS) OR A PLUG ADAPTER, AND SWITCH ON THE EQUIPMENT BEFORE OBSERVING THE ABOVE PRECAUTIONS

Spares Planning: In spite of good maintenance, equipment do breakdown suddenly. It may be something as simple as a fused bulb or a blown fuse or a broken handwone (bolt or screw). The equipment can be returned to service immediately, only if the required spares are readily available and the users know how to replace them. It is suggested that one set of the appropriate bulbs, fuses and a variety of assorted screws and bolts be kept in the immediate vicinity of the equipment. One simple rule for building stock of spares is when one spare is needed buy at least two of them and keep them safe.

Record keeping: It is important that a separate "Equipment Folder" is maintained for each of equipment and instruments in a hospital. Information on preventive maintenance and all repairs including replacement of parts should be kept in it. This will be very useful in evaluating the performance of the instrument and also at the time of subsequent repairs.

Maintenance Terminology: There are certain phrases used in the area of maintenance. It will be good to get a uniform understanding of these terms both to interact with suppliers and to follow this manual. The commonly used terms are described below.

Routine care is the responsibility of the actual users of the instrument. The first step in the care of instruments is understanding the working principle, the various operations and limitations in the use of instruments. It is a good practice to make rules in the institution like the person using the equipment is made responsible to ensure that it is switched off, well covered, smaller equipment kept in a special place, etc. One should be aware of the "DO's" and "DON'T's" with the instruments. These are generally supplied in the instruction manual that comes with the instruments. A pictorial display of the do's and don'ts as charts near the location of the instrument will always be a constant reminder for users. The manual also specifies the optimum operational conditions and specifications for the spares to be used when necessary. Keeping one set of all instruments operating and service manual in one place is very essential. They should be available for ready reference at all time.

READING AND FOLLOWING THE INSTRUCTION MANUAL IS A MUST FOR THE PROPER USE AND CARE OF EQUIPMENT

Routine care also includes constant watch on the detachable parts of the instruments (like eyepieces of slit lamps or microscopes) small accessories of instruments (like the model cornea or the weights in Schiötz tonometer) or the small instruments themselves (like Gonio lens) so that they are not pilfered by the visitors to the hospital.

Maintenance is giving the instruments a greater care by trained people (the maintenance staff) than the routine care done by the user. This is usually done periodically following a predetermined schedule. Such maintenance, also referred to as “*Preventive Maintenance*”, ensures trouble free and uninterrupted performance of the instrument for longer durations. Such schedules are worked out for all the instruments of the hospital so that under normal usage each instrument gets attention atleast once in seven to ten days (on an average of three to four times per month). Some time some maintenance may be needed when the instrument is being used. It is known as user-demanded maintenance. It is carried out to make the instrument work for that occasion to be followed by routine preventive maintenance. Preventive maintenance will include cleaning, lubricating all movable parts, checking for wear and tare of all parts and replacing the parts that might cause a break down of the equipment before the next preventive maintenance. Testing the functions of different parts of the equipment and checking the calibration will also be part of preventive maintenance.

Repair: In spite of good care and routine preventive maintenance an instrument, may stop functioning. This usually happens because of the ageing of certain components or due to some accidents. The accidents may be *mechanical* due to some impact, or *thermal* due to variations in the temperature of the environment, or *electrical* due to some unexpected variations in the line voltage. In all these cases, a good investigation of how the failure has happened will be very useful in carrying out the repairs. When an instrument fails to function, not all parts of it fail at the same time. One or more connected parts alone fail and identifying those parts is the first step in repair. This process is also referred to as “*Breakdown maintenance*” or “*Corrective maintenance*”.

Down Time: The period for which an equipment is unusable due to some repair is called down time. One should aim at keeping this as low as possible to avoid inconvenience for patients and loss of revenue for hospital.

Maintenance Contract: For expensive equipment that involves high technology for which spare parts may not be readily available, annual maintenance contracts offered by the supplier or his representative may be more advantageous. This will also serve as an insurance when there is any major breakdown in the equipment. In such cases monitoring to ensure that periodic maintenance and breakdown maintenance take place as per the contract should be the responsibility of the persons who take care of the other instruments in the hospital.

Withdrawal and disposal: Due to changes in technology and new instruments coming in, old equipment may get pushed aside. Instead of letting them remain idle, one could ‘retire’ old instruments, withdraw them from stock and dispose them off. If such disposal is only for the ‘scrap’ value of the instrument, it would be a good idea to remove all the screws, nuts, washers and optical elements from the instruments. These components could be used as spares for repairing similar instruments. Wherever possible, the best option would be to trade in the old equipment for the new ones.

CHAPTER - 2

Common Maintenance Tasks & Techniques to Handle Them

Dust: Dust and stain are two things that affect all instruments; dust is unavoidable in most of our hospitals. It is fine particles of sand mixed with organic material which spoil not only the appearance but also the working of the instruments. All instruments should be kept under suitable dust cover when not in use. Small instruments that are provided with storage boxes or dust covers should likewise be kept in the boxes or under dust cover when not in use. Maintaining a well groomed lawn or greenery surrounding a hospital and having curtains for doors and windows help in keeping the dust level down. Keeping the floor, furniture and fixtures free from dust helps in less accumulation of dust on instruments.

Stain: Besides dust, users handling instruments leave their finger prints on them. The finger print is mostly moisture of the sweat and some oily (greasy) material that leave a stain on the instruments. Stains are also caused by spillage of medicines, other liquids and discharge from patients. Both dust and stain tend to build up when not cleaned regularly. Old stains are usually hard to remove and can affect the functioning of an instrument. Some stains may also be sources of infection. Organic stain and organic material in dust may also help in the growth of fungus. The dust and stain on instruments can normally be removed with a clean moist cloth and this should be done everyday, ideally at the end of the day. Any possible infections stain as in tonometers should be taken care of after each use. The cloth may be gently damped with water or light soap solutions. Water or soap solution should not be sprayed on the instrument directly. The force of the spray may take water drops into the instruments that may cause rusting in due course.

THIS SIMPLE PROCEDURE SHOULD NOT BE ATTEMPTED FOR THE REMOVAL OF DUST AND STAIN ON OPTICAL COMPONENTS OF INSTRUMENTS.

Dust/stain on optical components: Almost all instruments used in an ophthalmic hospital have optical components like glass plates, lenses, mirrors, prisms, etc. They are very smooth surface and some of them may have some special coating on their surface for some special reasons. Hence great care should be exercised in removing the dust and stain on optical components. If wiped with a cloth, dust particles (sand) may leave a permanent scratch on the sur-



Fig 2.1. Shows the spiral path of the cleaning swab while cleaning circular optical elements

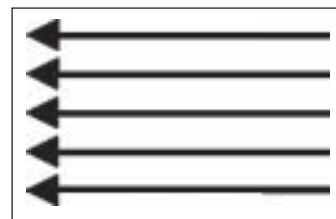


Fig 2.2. Shows the lateral path of the cleaning swab while cleaning rectangular or square optical elements

face of the optical components thereby causing unwanted scattering of light and reducing the quality of the final image seen. To avoid this, attempt should be made first to blow the dust off. Small bellows are available for this purpose. Canned air is also available for this purpose. They however tend to fog the optics due to freon gas contained in them. If the dust particles stick to the surface, a clean camel hair brush may be used to remove the dust. To remove stains, a cotton swab dipped in distilled water or mild detergent or alcohol (to be tried in this order) can be used to remove the stain depending on how severe the stain is. The swab is to be moved in a circular fashion starting from the center and going in a spiral towards the edge (see Figure-2.1). This is to be repeated using a fresh swab every time till the stain is no longer visible at any angle of observation under bright light. The pressure applied on optics should be just sufficient to remove the stain. Excess pressure should be avoided. Too much pressure will wear off the coating soon and the optical surface may become "bald" of the coating and lose its special property. Any cotton lint left on the component is to be removed by blowing or using a clean camel hair brush. For rectangular or square optical elements, the swab is to be moved always in one direction (see Figure-2.2). See Appendix II for more details.

Fungus on optical components: Sometimes fungi grow on optical components of instruments. Fungus can be removed like stain in the very early stage of its growth on optics. It is very difficult to remove the fungus growth if it is deep-rooted. Any attempt to remove the fungus at that stage damages optics. Quite often the only option is to replace the optics. Hence the first step in the care of an instrument against fungi is to prevent its growth. This can be achieved by keeping the instrument dry, as moisture helps the growth of fungi. A relative humidity of less than 60% is suggested. A small bag of desiccating agent like silica gel kept within the cover of the instrument helps in keeping the instrument dry. When an equipment is not located in an air conditioned room, the room should be well ventilated as ventilation helps in keeping the moisture level low. When the floor below the instrument is to be washed and if that area is likely to remain damp for some duration, the instrument should be removed to a dry location and brought in only after its location is dry. In humid places like coastal towns, one can keep the humidity around the equipment down by keeping it warm. An electric filament bulb (60 to 100W) kept glowing above the equipment will provide the necessary warmth. If it is a monsoon rain area a good cleaning of all optics at the end of monsoon period would remove any fungus in the early stage of growth.

Care of mechanical movable parts: All mechanical parts must be gently oiled to ensure smooth motion. One should not spray oil directly on to the instrument. Lubricating oil SAE 30 which is available in all petrol stations is adequate in most situations. However, refer to the user manual for specific lubrication recommendations. Instruments mounted on rollers should be periodically checked to ensure that the rollers roll smoothly and no vibration is communicated to the optical components when the instrument is moved. Likewise the locking mechanism should be checked and corrected if it is not working. It would be frustrating to the user if the equipment drifts at a critical step.

Care of painted surfaces: The best way to keep painted surfaces of the instruments clean will be to use normal car polish and clean cloth. One should however be very careful that the polish does not get either onto the optical components or into the joints of mechanical components and the plastic parts. Excess of polishing wax should be wiped off.

Care against pilferage: In some situations instruments or some of its easily removable parts may be pilfered intentionally or unintentionally. It is essential that proper care is taken to prevent pilferage. An instrument may not be useful if any part of it is missing and such a missing part may not be available readily.

Precautions during disassembling & assembling: Repairing an instrument or equipment is like carrying out surgery. When an instrument or equipment is dismantled, it involves the removal of several screws, bolts and nuts, knobs, etc. Each one of them should be correctly put back when the instrument is closed. Sometime at the end of a repair, one may end up with some surplus nuts, bolts, washers, etc. or may end up in a situation with a few missing screws. Though the instrument may seem to function even under such deficiencies, as a rule this should be avoided in the interest of the proper functioning of the instrument in the long run. Since the anatomy of different instruments or equipment is different and will be difficult to remember it will be a good practice to keep a record on paper of the parts removed for proper replacement. Tiny screws, springs or steel balls used in bearings may easily slip off during the “surgery”. Every attempt should be made to prevent such losses and to search for them when they fall off. Replacement of springs, steel balls, etc. may not be as good as the original. While working on instruments with tiny components it will be a good idea to have the working table covered with a rough cloth. Screws, springs or nuts do not roll off easily on the cloth as on the hard surface of a table. While dismantling an instrument, make it a habit to line up components or screws removed from left to right on the working table and in assembling, you will fit the components from right to left.

Care of fuses: A fuse is a device provided in electrical equipment for the safety of the instrument against any wrong use or misuse. Due to some defect in the operation of the instrument or due to some malfunctioning of some components, the instrument may draw excess current and this is when the fuse blows out protecting the equipment from the heat of the excess current. The rating of the fuse is suggested by the equipment manufacturer taking into account the maximum heat the instrument can bear without causing an accident or extensively damaging the equipment. When the fuse blows out due to electrical fluctuations or improper use, rectifying this problem and replacing the fuse will restore the equipment to normal use. When the fuse is blown off due to malfunctioning of any component in the equipment, replacing the fuse immediately will not help and the fuse may be blown off again. The defective procedure should be avoided and defective component identified should be replaced. Sometimes, due to ageing of the fuse it may be blown off when the instrument is turned on. If one is sure that there is no faulty operation and there is no obvious malfunctioning of the parts of the equipment, then the fuse may just be replaced. When a fuse is replaced, it should be replaced by a fuse of the same rating. If a fuse of the correct rating is not readily available, a fuse of lower rating may be used. For example, an instrument with a 300mA fuse may work with a 250mA fuse. However, in no case a fuse of a higher rating than what is suggested by the supplier should be used. Short circuiting the fuse by a thin wire or with aluminium foil may also make the equipment work but it deprives the equipment of the safety protection against any accidental high current. This may lead to extensive damage of the equipment.

NEVER SHORT THE FUSE WITH A WIRE OR REPLACE WITH ONE OF WRONG RATING. MOST FUSES LOOK ALIKE. SO ALWAYS CHECK THE RATING BEFORE USE.

Care of other electrical parts: Several of the ophthalmic instruments need electricity for their operation. Care of the electrical parts includes checking and dusting the switch, the wall socket, the wall plug and the connecting wire. Damaged or broken sockets and plugs should be changed. Only correct plugs and sockets should be used. An adaptor may be used to connect one type of socket to a different type of plug but that should be for short term use and testing only. Proper plugs and sockets should be installed as early as possible. The wires should be laid avoiding sharp kinks and ensuring that they do not get crushed under the rollers of the instruments or under the legs of the chair of the doctor or the patient and are not on the passage. After a few years of operation the insulation on connecting wires may become brittle and crack off. This may lead to short circuit and electric shock. Defects noticed in the switch, connecting wire, plug or the wall socket should be immediately rectified.

Care of bulbs: A bulb in an instrument should be turned off when the instrument is not in use. An electric bulb should be used at its rated voltage. A manufacturer says that an increase of 5% in the voltage supply above the rated voltage can decrease the life time by 50%. If a bulb is often turned off and on, its life time is decreased. While changing bulbs, care should be taken not to touch the bulb with bare fingers (Figure 2.3), especially if the bulb is a halogen bulb. Cotton gloves or paper towel may be used in such situations. If the lamp is touched accidentally, it should be wiped clean with a cloth moistened in alcohol. While removing a bulb from an instrument in which the bulb has just gone off one should remember that such bulbs, especially halogen bulbs, will be very hot and they may burn the fingers. One should allow sufficient cooling time and use cloth or suitable heat insulation before attempting to replace the bulb. It is for this reason most operating microscope and some light sources are provided with two bulbs. When one of them goes off the arrangement will be such that it can be quickly pushed out and second one pushed in using a handle to avoid any interruption. On such cases the fused bulb should be replaced as soon as it is convenient so that one does not use the instruments with just one bulb.

Care of foot switches: These must always be kept dry. They may be covered with water proof (plastic) covers without hampering any of its functions. A foot switch should never be picked up or moved by pulling the connecting cable. The cable may snap and one may not notice it till the switch is used again and it may be at a crucial moment.

Care of Electrical Ground: For the safety of the users, patients and the equipment, all electrical equipment should be properly grounded. This should be ensured at the time of installation. Periodic checking of the ground voltage is very essential. The electrical ground of the hospital should be well maintained and the voltage measured at the ground point in all panels periodically. It should be ideally zero but in practice can be about 1 volt. Several of the modern electronic microprocessor based instruments usually work on low voltages and they cannot tolerate a ground voltage of 1 volt or more. The instrument may fail if the ground voltage is more.

Care of cells: Some of the ophthalmic instruments like direct ophthalmoscopes use electric cells. The cells may be of “use and throw” type, or “rechargeable” type. In either case, when the instrument is not likely to be used for a few days continuously, the cells should be removed from the instrument. In the case of use and throw cells, fresh cells have a little more than the voltage rating of 1.5V which must be kept in mind while using the instrument. For example, most ophthalmoscopes have bulbs rated to work on 2.5V or 2.8V. A set of two fresh cells will have a total voltage of more than 3V. Under this condition, if the brightness knob is turned to its maximum, the bulb gets the maximum voltage of more than 3V, and may be fused out. When the instrument is in operation for a long time the cells weaken and the voltage gets reduced and under that condition the brightness knob may be turned to maximum.

Rechargeable cells come with different voltage capacities to suit the equipment. These should not be kept without recharging for a long time. At the same time every time after use they should not be recharged. They may be recharged at the end of the day. Such cells have a memory. If they are charged for a long time they can be used for an equally long time. If they are charged at short intervals they tend to get discharged quickly while in use. When loading the cells in the instruments the indicated polarity (+ve / -ve) should be adhered to.



Fig 2.3. How and how not to handle bulbs

Use and throw button cells and several of the rechargeable cells have toxic material like compounds of lithium, zinc, mercury, etc. Special care should be taken in disposing them off after use. They should be kept out of reach of children when not in use and ultimately buried in some marked place in the yard away from any water line. These cells may cause explosion when they are near fire and should not be disposed off in incendiaries with other hospital wastes.

After use one should make sure to switch off the battery. Some times the switch may not function properly while one may think the switch is off. It could be because of some loose contact, that may lead to continuous leakage current resulting in reduced life of the cells. Periodic checking of the switches of such instruments is necessary to ensure longer life for the bulbs.

Cells have a shelf life. When they are stocked for a long time the chemicals in them tend to get hardened and the life of the cell is reduced.

ELECTRICITY IS A GOOD SERVANT BUT A BAD MASTER.

General: Most equipment manufactured by well known manufacturers and supplied by well know suppliers are sturdy and will remain in good working condition once they are properly installed and tested. If subsequently there is a report of the instrument not functioning, do not suspect any defect in the instrument and start meddling with it. It is possible that the instrument is not properly switched on. There may be more than one switch between the instrument and the wall socket besides the switch of the instrument itself. It is possible that the instrument has been disconnected from the wall socket by some one other than the user. It is possible that there is no electricity in that socket though there may be electricity in the room. Only after checking all these factors one should attempt to examine the instrument for the possible cause of it not working.

CHAPTER - 3

Maintenance Management

Certain basic procedures should be followed to ensure efficient maintenance of equipment. Such systems can make sure that down time of certain equipment is kept to the minimum; major problems are minimized; maintenance costs are reduced; and the equipment is kept in optimal working condition. This chapter deals with some of the basic systems that should be followed to achieve a basic level of excellence in maintenance management.

Equipment Folder: As briefly mentioned in Chapter-1, an equipment folder should be maintained for every equipment and instrument (except surgical instruments). The equipment folder provides ready purchase and other information about the equipment. It is a record of preventive maintenance carried out and a history of repairs done with details of spares used and costs. A suggested format is as given below:

Cover page of the equipment folder should have the following information:

Name of the equipment		
Name and address of manufacturer		
Mfrs. & Model Sl.No:		Hospital Sl.No:
Location		
Supplier's Name, Address, Phone Fax, E-mail, Web contacts.		
Date of supply		Price: Rs.
Warranty details		
Maintenance Contract details	Give details of number of visits to be made and the nature of contract - whether comprehensive or only labour.	
Spares to be kept		
Spares can be purchased from	1.	2.

In the case of surgical instruments, it may not be practical to maintain a folder. However for each repair, a job card must be made and can be filed for the type of instrument.

The following records are to be kept inside the folder:

1. Preventive maintenance record (format given on page 12)
2. Breakdown maintenance record (format given on page 13)
3. Record of maintenance under maintenance contract (if applicable) (format given on page 14)

PREVENTIVE MAINTENANCE RECORD

Name & Model		
Mfrs. Sl.No:		Hospital Sl.No:
Location		

Record of preventive maintenance (Including dates and initials of person who has carried out the maintenance)

Date due	Date of actual maintenance	Initials	Date due	Date of actual maintenance	Initials	Date due	Date of actual maintenance	Initials

The details of the preventive maintenance activities to be carried out for each specific equipment may be listed on the rear side of this sheet. If there are several levels of preventive maintenance to be carried out at different periodicity that may also be specified. For example the optics of the slit lamp may have to be checked and cleaned more often than the up-down movements of the slit lamp table or the joy stick movements

BREAKDOWN MAINTENANCE RECORD

Name & Model			
Mfrs. Sl.No:		Hospital Sl.No:	
Location			

Record of breakdown maintenance

Date	Job card ref.	Details of major faults rectified spares used and cost involved	Initials

RECORD OF MAINTENANCE UNDER MAINTENANCE CONTRACT

Name & Model			
Mfrs. Sl.No:		Hospital Sl.No:	
Location			
Contract details	Periodicity of agreed regular calls, Number of breakdown calls, scope of contract, etc.		
Expiry Date		Amount (for the year):	
Contact person, address, phone & e-mail contact			

Record of maintenance under Maintenance Contract

Date	Nature of call Regular or break-down call	Details of work done and spares used	Initials

JOB CARD

For every repair job, a job card has to be made. The job card should contain all information such as nature of complaint, how it occurred, who noticed the problem, work done, spares used, time taken, name of technician and cost estimate. This should be done immediately on receiving the equipment for repair.

* Name of person or Department giving equipments for repair:		Date Received:
Equip. Name & Model:		
Mfrs. Sl.No:		Hospital Sl.No:
Location/Dept.:		
Cost estimate:		Date Returned
Nature of the problem		
How it occurred:		
Diagnosis:		
Details of work done:		
Details of spares used:		
Time taken: (approximately)		
Reasons for undue delays, if any:		
Initials of technician(s)		
Quality control check by:		
Remarks: # Name of the person who takes the instrument out after repair		

To make such records useful, all entries in the card should be updated every day by the instrument maintenance persons and scrutinized by the department head. Where computer facility exist the data should be maintained in the computer. In the case of heavy equipment to be repaired at their location, this entry (*) will be the name of the person who informs the maintenance department. This entry (#) will be the name of the person who accepts the instrument after repair.

Frequency in maintenance: As mentioned in Chapter-1 preventive maintenance is essential for trouble free uninterrupted performance of any equipment. Disassembling and assembling certain parts of an equipment does wear out the equipment to some extent. There is thus a danger of wearing out an equipment by over maintenance. A

frequency of once a week suggested in Chapter-1 is therefore to be taken as a suggestion and not as a rule. The frequency for each equipment/instrument is suggested in Section-II. If the equipment is sparingly used for a period and there is no noticeable malfunctioning, the preventive maintenance may be at the level of routine care. If the instrument is used very heavily and one notices some malfunctioning, however small it may be, maintenance is to be carried out more frequently. In working out the frequency of maintenance, there should be a good interaction between the users of the equipment and the maintenance persons. Formal meetings of doctors, paramedical staff and instrument maintenance persons should become a regular activity in the hospital.

Spares Planning: Spares planning for equipment and instruments is an important aspect of maintenance management. Spares are of two types:

- ▶ One, wherein the consumption can be reasonably predicted like bulbs, battery cells, rubber tubings, etc.
- ▶ The other, where the usage cannot be predicted like fuses, bolt and nuts or a fragile part of an equipment that break off.

Some of the other considerations in planning for spares are:

- ▶ Estimated consumption
- ▶ Shelf life
- ▶ Purchase lead time - especially in the case of spares that have to be imported.
- ▶ Equivalent items with some imagination and skill, it is also possible to make some spares, especially the bulbs, using the bulb available for other applications. One should note that bulbs used in ophthalmology are the ones used in automobiles or for decoration in shop windows.
- ▶ Other friendly users of similar instrument in the same area for borrowing if necessary.

Keeping adequate stock that would last for about 6 months and placing orders for the next consignment when the stock reduces to about 50%, might be a useful formula to follow.

Hardware spares: In spite of all precautions, some loss of screws, nuts and bolts may take place, and some times those items may also break or wear out. Hence a stock of some standard size bolts, nuts, screws, washers, should be maintained. When a screw head or a bolt head is damaged it should not be used again. A damaged screw will be more difficult to remove the next time. It is safe to replace damaged screws and bolts immediately. One should remember that whereas most of the screws, bolts, etc. may be in inch specifications, several of the German and Japanese equipment use screws of millimeter specification. Such screws are not interchangeable.

DO NOT FORCE A SCREW OR A BOLT IN AN EQUIPMENT IF THE FIRST FEW TURNS ARE NOT EASY AND SMOOTH.

Storage of spares: This is as important as having the spares. One must be able to locate where a spare part is stored so that one may get it without having to search for it in a pile. Special storage racks, bins, set of drawers are available for different types of spares. Spares do get mixed up during usage. Time spent periodically in sorting them out will be worth spending, so that when a particular item is needed one may be able to get it without much searching.

Section - II

CHAPTER - 4

Torch Light

Description and purpose: A torch light is the first instrument an ophthalmologist uses to examine the eye of a patient. A good torch light should give a circular patch of light of nearly uniform brightness.

Several models of torch light are available in the market. Any one of them would suit the purpose. The light from a torch light that uses two of the regular 1.5V dry cells and a bulb of 1 or 2 watt rating is sufficient for the initial examination. If the light is such that it uses the dry type D cells it can be used for several weeks for normal usage before the cells are to be replaced. Torch lights with rechargeable cells are also available.

The front glass cover, the bulb, the concave reflector, the switch, the cells and the barrel are the main parts of the torch cell.

Proper use and tips for optimum performance and long life: The cells are the ones that need constant replacement. At Rs.8 a cell, this can become a significant expenditure especially if the torch is heavily used. This can be overcome by replacing the cells by a 220 to 3 volt (500mA) step down transformer readily available in the market. The transformer fits conveniently into space in the barrel intended for the cells (Figure 4.1). A further refinement to this could be a simple rectifier-cum-voltage regulator circuit which could also be fitted into the barrel with the transformer. This would give a longer life for the bulb by providing a constant voltage to it even though the supply voltage may fluctuate (a printed circuit board for this designed at Aravind Eye Hospital Madurai is available at a nominal cost for those who want it). The cost of this conversion will be approximately Rs.200. With this arrangement the torch light can be used on the regular electrical supply from the wall plug. The downside is that it cannot be used in all places or at times when there is no power supply.

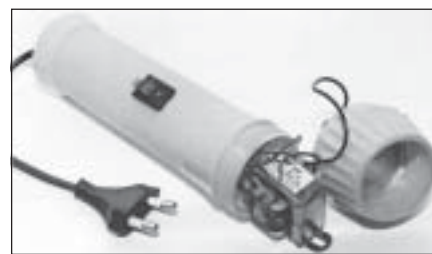


Fig 4.1. An electric torch with front end open and transformer pulled out

- ▶ Keep the torch light off when not in use
- ▶ If the torch light is not likely to be used for more than a day remove the cells and keep them separately. If the cells remain in the barrel with the torch light not in use for several days, there will be some leakage from the cells resulting in corrosion of the barrel and switch contacts.
- ▶ The torch light generally rolls off the desk of the ophthalmologists and the front glass or the barrel of the torch cracks or breaks. To avoid this, provide a special stand or a tray for the torch light where it could be placed every time after use. In case such a stand or tray is not readily available, keep the torch light on a hand towel spread on the desk which would prevent the rolling of the torch light.
- ▶ In the case of torch light with a transformer, the connecting wire should be long enough so that it does not get stretched tight during examination. At the same time it should not be too long as it might be

rolling on the floor getting entangled in the feet of people, especially the patients walking near the examination desk.

User level care and maintenance:

- ▶ Wipe the dust on the barrel of the torch light and on the front glass every day.
- ▶ When the illumination is not sufficient, replace the cells with fresh cells.
- ▶ When the bulb is ‘fused out’, replace it with the same type of bulb. A different bulb may have the filament displaced and it may not be at the focus of the reflector. When this is so, the beam of light may not be uniform. There may be some dark regions in the patch of light obtained with the torch light.
- ▶ In the case of a torch light with the transformer described earlier, check the soldered electrical connections made at the transformer terminals and at the switch.
- ▶ Equipment or drug suppliers sometimes provide pocket torch light as part of their business promotion activity. These are usually intended to be of use and throw type. The bulbs in such torch lights last longer than the cells. They can be put back into use by carefully cutting open the barrel, removing the used up cells and replacing them with two AAA cells available in the market and sealing the barrel with insulation or any adhesive tape. This process can be repeated till the bulb goes off. Those bulbs are special with built in lens at the top. Replacement bulbs may also be available in some places.

Preventive maintenance: No special preventive maintenance is needed.

Trouble shooting and repair:

- ▶ No illumination
 - bulb ‘fused’: Remove the bulb, check continuity using a multimeter and change the bulb if there is no continuity.
 - If there is continuity in the bulb and the bulb still does not glow, then check the switch and rectify contact problem if any. The switch is usually a press and slide type. The press operation makes the initial contact while the slide operation makes the contact permanent. When the switch is not functioning, the tip of the copper plate that makes the contact may be tarnished or corroded. Scrapping the surfaces clean with fine sand paper would restore contact. The switch may be replaced by a single pole switch available in any radio spare parts shop.
- ▶ Poor illumination even with fresh cells: This could be due to scratches on the front glass (clear plastic) cover or due to tarnished reflector. Both these items can be changed. Those parts are generally available in shops selling torch lights, bulbs, cells, etc.

Calibration / Quality Control: The torch light should give a bright spot of light of uniform illumination when the light is aimed at a wall from a distance of about half a meter in bright day light.

Strategic spares:

- ▶ A spare bulb
- ▶ A pair of fresh cells

Tools needed:

- ▶ Multimeter
- ▶ Knife
- ▶ Soldering iron and solder

CHAPTER - 5

Ophthalmoscope

Description and Purpose: Ophthalmoscopes are of two kinds direct and indirect. Direct Ophthalmoscope which is usually referred to as ophthalmoscope, and sometimes briefly as the 'scope', is a very handy instrument for the examination of the retina around the fundus. Light from a bulb is reflected at right angles and projected as a spot through the iris of the patient to illuminate the retina. This reflection is achieved using a front silvered mirror or partially silvered mirror or a total reflecting prism in different scopes. The illuminated retina is seen directly by the doctor through the iris of the patient. A disc with lenses of different powers is provided in the instrument and a lens of required power can be brought in the line of sight to correct any refractive error of the patient or of the doctor himself if he does not look through his spectacles. The doctor looks just above the front silvered mirror and the reflecting prism or through the partially silvered reflector mentioned earlier. An image magnified nearly fifteen times is seen.

Description of major subsystems: The Ophthalmoscope has two major subsystems.

1. An electrical system
2. An optical system also known as the head.

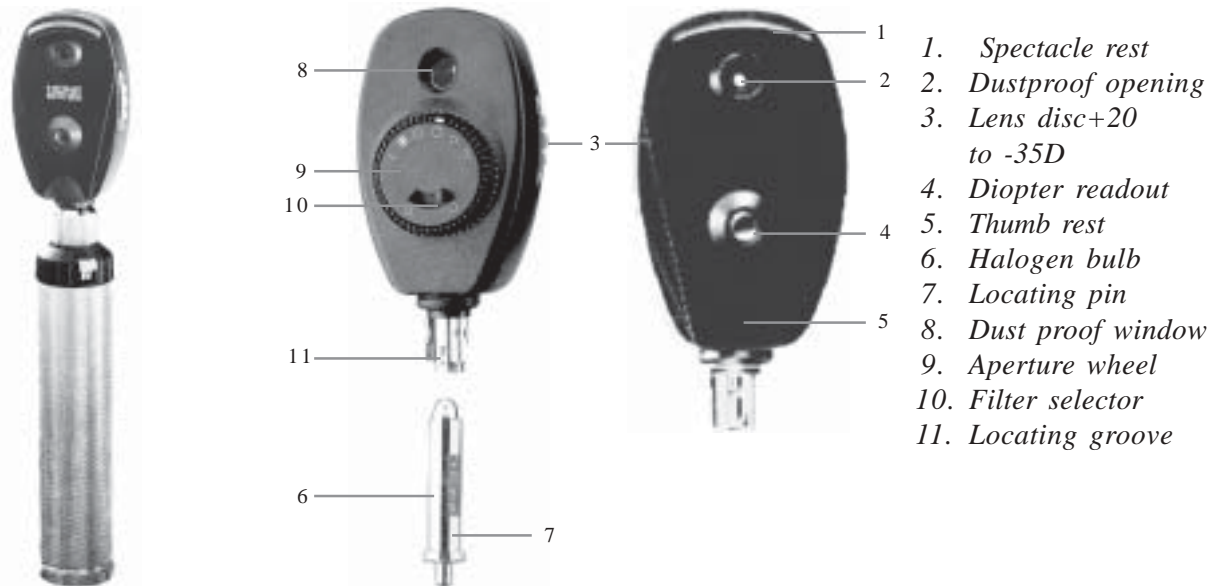


Fig 5.1 Ophthalmoscope, with labelled parts

All ophthalmoscopes are almost identical in construction. A picture of an ophthalmoscope with labelled parts is shown in figure 5.1.

The electrical system: This consists of either dry cells or a rechargeable battery, used to light a bulb through a switch and a rheostat (a variable resistor) that controls the current through the bulb for changing its brightness. Some ophthalmoscopes run on the main electric supply through a step down transformer. The tube in which the cells (rechargeable battery) are kept also serves as the handle for the instrument. The instrument that works on mains supply is provided with a solid handle. As in the case of torch light described in chapter-4 it is possible to convert locally a battery operated ophthalmoscope into an mains voltage operated one using a suitable step down transformer and an associated regulator circuit.

The optical system (the head): This is fitted on the handle with a spring loaded locking or screw mechanism. It consists of (1) A system of condensing and focusing lenses and a reflector (a front coated mirror or a total reflecting prism) to produce the spot of height and (2). The viewing system consisting of a disc with lenses of different powers usually ranging from -20 to +20D. In some instruments a high positive or a high negative lens can be brought in by a sliding adjustment. In some instruments that have a much wider range of powers (-40 to +40D), two wheels carrying the lenses are provided and a combination of two lenses give the required power. The power of the lens used for viewing is indicated on the disc and can be seen through a window in the head. The reading is illuminated using a partially reflecting plate held in the path of the main light beam. There exist provisions in the head for changing the spot size or for obtaining a semi-circular spot or for reducing it to a streak or to provide concentric circles on the spot using different stops in the path of the light beam. Also there is provision for introducing filters (red free or polarizing) in the path of the light for special applications. The ray diagram of the optical system is shown in figure 5.2.

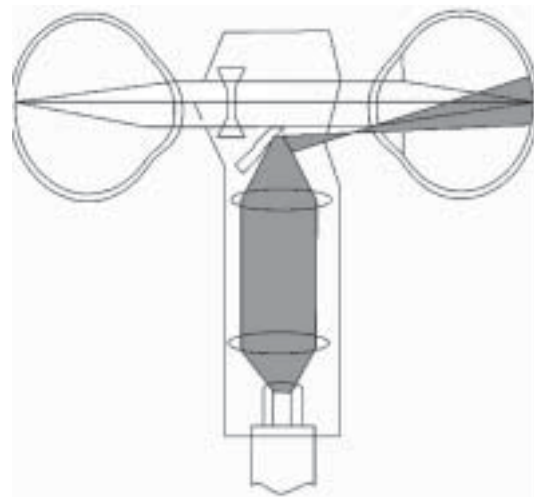


Fig 5.2 The ray diagram of the optical system

Proper use and tips for optimum performance and long life: In an ophthalmoscope, the cells are the ones that need replacement most frequently. The cells run down steadily on usage. This can be seen by the decrease in brightness of the spot. Usually the ophthalmoscopes run on two 1.5V cells. When the cells need replacement, both the cells should be changed. Most ophthalmoscopes use 2.5V or 2.8V bulbs; when fresh cells are loaded, the maximum voltage could go up to about 3.1V. Under such situations to protect the bulb from getting “fused” out, the rheostat should not be turned to maximum brightness positions. After use when the instrument is turned off the user must turn the rheostat all the way down till a click sound is heard while turning the switch off. If this is not observed the instrument remains on. Though there may be no visible light output, the cells will continuously get discharged and a new pair of cells may drain off completely. In the case of ophthalmoscopes with rechargeable batteries, the batteries should be charged periodically (at least once a week or once in three or four days depending on usage). In either case when the instrument is not likely to be used for a few days at a stretch the cells/battery should be taken out of the instrument and kept separately. The above problem does not arise for instruments running on main power.

The bulb may fail during usage. To prevent this, one should avoid sudden jerks or impact of the instrument on the table or any near by fixtures during use. The filament of the bulb breaks easily when it is hot.

User level care and maintenance:

- ▶ Remove the dust and stain on the outside of the instrument daily.
- ▶ When not in use keep the instrument in the box or pouch provided.
- ▶ While storing the instrument, keep the lens disc on zero setting so that no dust builds up on the other lens (zero setting is just a hole).
- ▶ Some ophthalmoscopes are provided with shutter for the peep hole. It should be used to keep the hole closed when the instrument is not in use.
- ▶ Being a portable instrument that the doctor might want to carry during his rounds, it should always be carried in its box or the pouch to avoid any accidental damage in transit.

The ophthalmoscope head is fitted on the handle with a spring attachment in some instruments. The spring is sturdy and usually lasts for long time. It is advised not to disturb the setting. It is however possible to put it back in case it is required. Some practice may be needed for this.

Preventive maintenance:

Care of electrical systems: As indicated earlier, when the instrument is not likely to be used for a few days together, remove the cells/rechargeable battery from the instrument and keep them separately. The rheostat has a movable contact and some dust may accumulate on the rheostat and below the contact and wear out the rheostat. Clean the rheostat contact using a drop of petrol or kerosene. A drop of light lubricating oil may be used to provide smooth movement.

Care of optical system: In spite of best routine maintenance, some dust may enter the head causing the appearance of some dark spots and also loss of illumination of the spot. To remove the dust on the components inside the head, the head may be carefully opened. This is achieved by removing two or three screws on the head (refer to hand book/instruction manual of the supplier). The lens disc can be washed and dried. The lens disc can also be cleaned with distilled water in an ultrasonic cleaning bath if the dust cannot be removed with cotton swab. In the modern instruments, this disc is a single piece with all the lenses moulded on it. In the older models, tiny lenses are sandwiched between two discs. Attempt should not be made to separate the discs to clean the lenses. If the lenses fall off, it would be very difficult to identify the power of each of them and to put them back into correct position. The dust on the other optical components may be removed with a cotton swab dipped in distilled water. The head may have tiny springs or steel balls for spring loading the movement of the lens wheel and other discs. Extreme care should be taken not to lose them during cleaning. It would be almost impossible to replace those tiny parts. Ophthalmoscopes used by doctors who smoke, get a fine deposit of soot on the optics. Their ophthalmoscope require cleaning more often than those of non-smokers.

Preventive maintenance schedule: Suggested frequency—once in six months or once a year for optical system depending on how soon the brightness of the spot is reduced in six month for electrical system.

Check list for preventive maintenance:

- ▶ Do you get a spot of uniform brightness when the instrument is turned on?
- ▶ Does the brightness of the spot vary when the rheostat is operated?
- ▶ Does the lens wheel rotate and get locked in position for the different powers?

- ▶ Does the size and shape of the spot vary when the corresponding aperture stops are moved in?
- ▶ Do the filters come in position when the filter disc is turned on?

The answer for all these should be “yes”. If not, action should be taken as described under trouble shooting.

Trouble shooting and repair:

Bulb not glowing or the glow is weak:

- ▶ Remove the bulb and check for continuity in the bulb using a multimeter.
- ▶ If continuity exists, the fault is in the electrical system.
- ▶ If there is no discontinuity, replace the bulb. Some times there may be continuity but the bulb may be black. Such bulbs do not give out sufficient light and need to be replaced. As described earlier care should be taken not to touch the bulb with bare fingers. There will be a small notch on the side of the bulb and a corresponding recess in the bulb holder so that the bulb can go only in one position in its holder.

Fault in the electrical system:

- ▶ Check the operation of switch and rheostat using a multimeter and clean the contact, and replace them if they are defective.
- ▶ Check the voltage in the cells / rechargeable battery. Replace the cells or recharge the battery if the voltage is low.
- ▶ If the cells runs down very fast it may be because the switch is not functioning properly and the current is drawn from the cell even when the switch is ‘off’. In such situations clean the switch mechanism. If found defective replace it. Usually the rheostat and switch come as a unit and are replaced together.
- ▶ In the case of instruments running on mains power, check the connecting wires for continuity and replace them if necessary. In these instruments, if the switch and the rheostat fail, external switch and rheostat may be provided at the power supply.
- ▶ If there is continuity and the bulb is not glowing, check the switch and the transformer in the power supply and replace them if necessary.

When to call an expert?: Almost all the problems in an ophthalmoscope can be handled at the institution level. However the following condition warrant the services of the supplier or an expert:

- ▶ When the locking mechanism of the head with handle is not functioning.

Calibration / Quality Control: After the preventive maintenance, the overall functioning of the ophthalmoscope must be checked to see whether it is satisfactory.

- ▶ Check the light intensity of the spot. When aimed at the wall about 25cm away, the spot should appear bright in bright day light.
- ▶ Check the movement of the lens disc. It should be smooth and at the same time the disc should get locked in the correct position after each shift.
- ▶ Check the movement of the different stops and filter. They should be smooth and here also each one of them should get locked in position, after shift.

Strategic spares:

- ▶ A spare bulb
- ▶ A pair of fresh cells

Tools needed:

- ▶ Multimeter
- ▶ Watch makers screw driver set
- ▶ Watch makers Allen wrench set
- ▶ Soldering rod and solder
- ▶ Optics cleaning supplies

CHAPTER - 6

Retinoscope

Description and purpose: Different types of retinoscope are used. One of them, the streak retinoscope described here, is the most common instrument. It is used in the objective evaluation of the power of the spectacles needed to correct the refractive error of patients and also in determining the axis and cylindrical power needed for patients with astigmatism. As in direct ophthalmoscope (chapter-5) light from a bulb is reflected at right angles and is projected on to the eye of the patient. The light is either a rectangular patch (known as plane mirror mode) or a streak of light of variable width (concave mirror mode). The instrument is generally used in the cubicle of refractionist/optometrist which is usually dark.

Description of major system: The streak retinoscope has the two major subsystems like direct ophthalmoscope

1. An electrical system
2. An optical system known as the head.

Several suppliers supply a streak retinoscope head that fits onto the handle of the direct ophthalmoscope that holds the electrical system. Thus one can get a two-in-one set and save some cost.

All streak retinoscope are almost identified in construction. A picture of the retinoscope head with labelled parts is as shown in figure 6.1

The electrical system: Same as the one of direct ophthalmoscope except that streak retinoscopes use a bulb with straight filament (The bulbs of ophthalmoscopes and retinoscopes are not interchangeable).

The optical system: The distance between the focusing lens of the instrument and the bulb is movable. This is done by moving a sleeve up or down. This produces either a patch of light or a streak of light of variable width. The bulb is positioned in such a way that it can be turned about the axis of the instrument usually by turning the same sleeve. This results in the rotation of the patch of light or the streak about the line of sight of the user. The reflector used is always a front silvered mirror and is much wider. In some instruments the reflector has a peep hole at the centre of the reflector. In other instruments the user has to look just above the reflector. The lens disc present in ophthalmoscope is not present in streak retinoscope.



Fig. 6.1. Retinoscope heads,
Two models

Proper use and tips for optimum performance and long life: Same as for direct ophthalmoscope (page 20, chapter 5)

User level care and maintenance: Same as for direct ophthalmoscope (page 21, chapter 5)

Preventive maintenance:

Care of electrical system

Same as for direct ophthalmoscope (page 21, chapter 5)

Care of optical system: Same as for direct ophthalmoscope (page 21, chapter 5). One additional feature is to remove the sleeve that moves the lens up and down and clean it. Gentle lubrication of the sleeve will help smooth movements.

Preventive maintenance schedule: Same as for direct ophthalmoscope (page 21, chapter 5)

Check list for preventive maintenance:

Do you get the patch of light or streak of uniform brightness when the instrument is turned on?

Does the brightness of the patch of light or streak vary when the rheostat is operated?

Does the sleeve in the instrument move up and down freely and give a path of light or streak of variable width when it is moved?

Does the patch of light or the streak rotate when the bulb is turned using the sleeve?

The answer for all these should be "yes". If not, action should be taken as described under trouble shooting.

Trouble shooting and repair

Bulb not glowing: Same as for direct ophthalmoscope (page 22, chapter 5)

Fault in the electrical system: Same as for direct ophthalmoscope (page 22, chapter 5)

Fault in optical system:

- When to take an experts help?:
- When the locking mechanism of the head with the handle does not function.
- Sleeve does not rotate and/or it does not move up and down. Loosen the screw holding the sleeve and remove it. Remove all dust, rust if any and gently lubricate it.

Calibration / Quality control:

- After preventive maintenance, the overall functioning of the steak retinoscope must be checked to see whether it is satisfactory.
- Check the light intensity. When aimed at the wall about 60 to 100 cm away, the patch of light or streak should appear bright in a semi darkened room.
- The movement of the sleeve that gives the patch of light or streak of variable width and its rotation should be smooth.

Strategic spares:

A spare bulb

A pair of fresh cells

Tools needed:

Multimeter

Watch maker's screw driver set

Watch maker's Allen wrench set

Soldering rod and solder

Optics cleaning supplies

CHAPTER - 7

Indirect Ophthalmoscope

Description and Purpose: The modern Indirect Ophthalmoscope functions as the eye piece of a stereomicroscope for which a hand held high positive aspheric lens (17D, 20D or 30D) serves as the objective. When viewed properly, a magnified image of the retina is seen. Some of the advantages of the instrument as compared to the direct ophthalmoscope are (1) stereoscopic view (2) greater field of view (3) increased illumination and (4) reduced distortion. An additional advantage is that the doctor is at a distance from the patient. However, the final image seen is inverted and the magnification is much lesser than in a direct ophthalmoscope.

Description of major subsystems: An indirect ophthalmoscope has four major subsystems.

1. An illumination system
2. An electric system
3. A stereoscopic viewing system (vision box)
4. A head band that supports the illumination system and the vision box

All models of the indirect ophthalmoscopes are similar in construction. A picture of Indirect Ophthalmoscope is shown in figure 7.1

The Illumination System: This consists of a tungsten filament lamp or a halogen lamp and a front silvered concave reflector suitably positioned behind the lamp. Two condensing lenses are placed in front of the lamp. The lens close to the lamp is fixed while the other lens could be moved forward or backward and fixed in position with the help of a spring loaded screw. There is provision for introducing filters of required characteristics in the path of the light. The light coming through the second lens is reflected using a front silvered mirror to provide the illumination at the eye of the patient. The mirror could be tilted and fixed in any required position for easy examination. The size of the spot could be varied by pushing in stops of different sizes in the path of the light near the bulb.

The Electrical System: This consists of a step down transformer provided with a switch, a rheostat, a fuse and a sufficiently long connecting cable. The transformer is either fixed on the wall near the examination table or kept in the box of the instrument.



Fig. 7.1. Indirect ophthalmoscope.
Top - Head band mounted
Bottom - Spectacle mounted

The Vision Box: This has two eye pieces. They can be moved laterally in the vision box to match with the inter pupillary distance of the doctor. The hand held high power positive aspheric lens gives a real inverted image of the patient's retina in space in front of the lens. The light from this image meets a 90° wedge formed by two mirrors in the vision box. The wedge divides the beam into two beams which are further reflected by two 45° mirrors (or total reflecting prisms) before they reach the eye of the doctor through the eye pieces. The ray diagram indicating the working of vision box is as shown in figure 7.2. The vision box is rigidly attached to the illumination system. This is usually well sealed so that no dust enters the box.

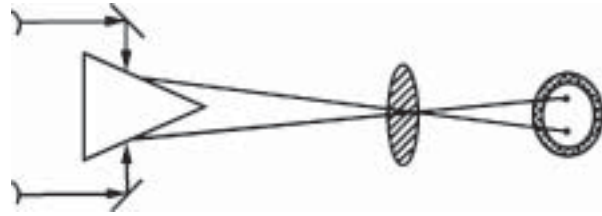


Fig. 7.2. The ray diagram indicating the working of vision box



Fig. 7.3. The teaching attachment

In some instruments, a pair of semi-silvered reflectors can be fixed in the vision box. These are known as teaching attachments. They are useful for assistants (students) to look at what the doctor is looking at. The picture of an indirect ophthalmoscope with this attachment is shown in Figure 7.3.

The Head Band: The illumination system and the attached vision box are attached to a head band that a doctor can wear conveniently. The cable for the lamp is also attached to the head band. The illumination system, vision box combination could be tilted and fixed at the desired position using screws on the head band. While in use, the eye pieces are as close to the doctor's eyes as possible to give a wide field of view.

The illumination system and the vision box are also attached to a spectacle frame.

The box provided for the instrument is such that when not in use the instrument together with the head band and the cables could be kept in marked positions in the box. Sometimes, the instrument with the head band is kept hanging on a hook on the wall near the examination area. Since the examination using indirect ophthalmoscope is done without any external light, one can arrange such that when the ophthalmoscope is removed from its hook the room light is turned off and the light is turned on when the instrument is back on its hook.

Proper use and tips for optimum performance and long life: In an indirect ophthalmoscope it is the bulb that fails most frequently. The following precaution can help in prolonging its life.

- ▶ Use the bulb in the low illumination setting and increase it to high illumination setting only for brief periods when there is a need.
- ▶ If wide fluctuation in the voltage is found in the location where the instrument is being used, a spike controlled voltage stabilizer may be provided.
- ▶ The instrument should be hung using its head band only and should never be hung on a hook by its electrical cord. This may cause electrical failure.

User level care and maintenance:

- ▶ Remove the dust and stain on the instrument daily.
- ▶ When not in use, keep the instrument in its box and keep the box closed.
- ▶ The head band may get oily and may also become wet with the sweat of the doctor. The instrument must be wiped clean to remove the oil and the sweat, and powdered. In spite of the above care, after continuous usage the foam pads of the head band may become soiled and worn out. They may be replaced with fresh extra pads

Preventive maintenance:

Care of Electrical System: The switch and the rheostat in the electrical system may wear off in usage. Check them for smooth movement and proper functioning. Replace them if found defective.

Care of Optical System: As described earlier, the optical system in the vision box is well sealed so that no dust enters the box. It is enough if the exposed lens surfaces are cleaned. The instrument is so constructed that the two eye pieces slide on groves provided and as long as they are not disturbed a single image is seen, after the inter pupillary distance adjustment. If the eye pieces are disturbed and do not move in the groves provided, diplopia may be caused. To correct this, the eye pieces should be brought back to move on the groves provided.

Preventive maintenance schedule: Suggested frequency - once a week.

Check list for preventive maintenance:

- ▶ Do you get a clear spot of light when the instrument is turned on and the light beam is obtained on the wall or table top at a distance of one meter?
- ▶ Does the brightness of the spot vary when the brightness control knob is operated?
- ▶ Do the filters move in and out of the path of the beam as desired?
- ▶ Do you see a single image while looking through the eye pieces?
- ▶ Do the head band fittings move freely when the knobs are turned ?
- ▶ Does the spectacle fit properly in the case of spectacle mounted instruments?

The answer to all these should be "yes". If not, action should be taken as described under trouble shooting.

*Trouble shooting and repair:*Bulb not glowing:

- ▶ Turn off the power supply and remove the bulb and check for continuity using a multimeter.
- ▶ If continuity exists the fault is in the electrical system.
- ▶ If not, replace the bulb. Care should be taken not to touch the new bulb with bare fingers.

Fault in the Electrical System:

- ▶ Check the continuity in the fuse in the power supply.
- ▶ If the fuse has continuity and the bulb does not glow check for continuity in the connecting wires. Replace them if there is any discontinuity.

- ▶ If the fuse is having continuity and the connecting wires also have continuity and still the bulb does not glow, check the switch. If it is defective replace it.
- ▶ If the fuse is blown only, look for any obvious short circuit in the electrical system.
- ▶ If there is no obvious short circuit, replace the fuse with a fresh fuse of the correct rating specified in the instrument.
- ▶ Turn the power on. If the bulb glows, the instrument is ready for use.
- ▶ If the fuse is blown, once again there is some hidden short circuit that needs more careful investigation.

When to take an expert's help?:

- ▶ When the instrument is badly damaged by impact
- ▶ When the electrical short circuit is not obvious and the fuse gets blown on every time it is replaced. This may involve replacement of the transformer and other circuit element. In such situations the power supply may be replaced by a locally available low voltage DC or AC power supply that can supply the required current at the required voltage.

Calibration / Quality Control: After carrying out preventive maintenance or rectifying a fault the overall functioning of an indirect ophthalmoscope must be checked to see whether it is satisfactory. While it may be difficult to establish objective standards and measurement methods, the following should be done.

- ▶ Check the intensity of the spot. It should appear bright even in day light.
- ▶ Check the movements of the vision box, the tilting mirror, the filters and aperture and the eye pieces. All movements should be smooth.
- ▶ Check the movements of the knobs in the head band. They should also be smooth and at the same time provide the necessary grip at the required setting.

Strategic spares:

- ▶ A spare bulb
- ▶ A spare fuse

Tools needed:

- ▶ Multimeter
- ▶ Watch makers screwdriver set
- ▶ Watch makers wrench set
- ▶ Soldering rod and solder
- ▶ Optics cleaning supplies
- ▶ Cloth and powder for cleaning head band

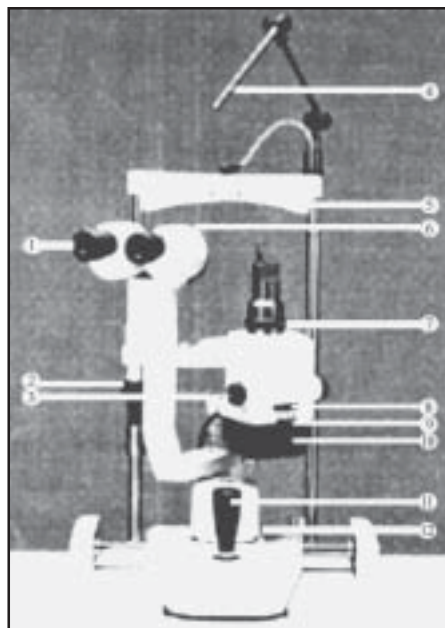
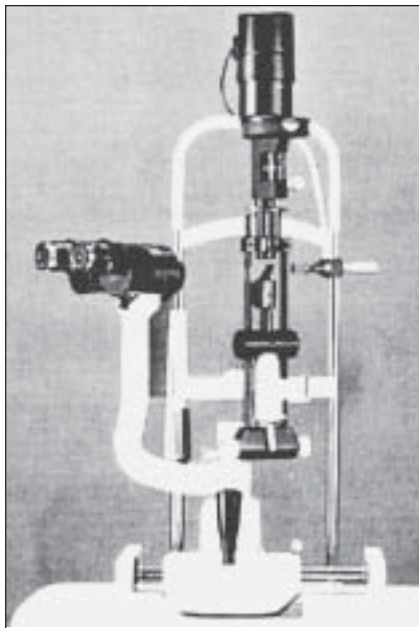
CHAPTER - 8

Slit Lamp

Description and purpose: The slit lamp is one of the most commonly used diagnostic instruments of an ophthalmologist of today. It provides illumination and magnification for examining the eye and its various parts. The light is projected as a bright slit, thereby enabling detailed examination of the eye in small segments. It is used in the examination of the anterior segment of the eye, including the crystalline lens. With supplementary lenses the slit lamp is useful in the examination of the posterior region of the eye and the chamber angle, the fundus and good part of the retina. A number of accessories can be added to a slit lamp to convert it into a measuring instrument as well. One can measure intraocular pressure, the curvature of the cornea, the thickness of the cornea, the distance between the cornea and the lens, the anterior chamber volume, the opacity, etc. using different attachments. Some slit lamps can have camera attachment for photographic recording. Slit lamps are also used to deliver laser beam spots at any required place in the eye for treatment.

Description of major subsystems: A modern slit lamp consists of three major components:

1. An illumination system - light source, mirrors & prisms
2. A magnification system - the bio microscope
3. A mechanical system that links the magnification with the illumination system and provides vertical and lateral movements to focus the light on the desired part of the eye.



1. 10X Eyepieces
2. Chin-Rest Elevation Control
3. Slit Width Control Knob
4. Fixation Target
5. Forehead Rest
6. Magnification Changer Lever
7. Slit Rotation Control Ring
8. Aperture and Slit Length Control Wheel
9. Filter Selection Lever
10. Lamphouse Cover
11. Joystick
12. Cross-Slide Base

Fig. 8.1. Slit Lamp (Two models)

Generic models: There are essentially two types of modern slit lamps that are in use. One has the illumination system at the top while the other has it at the bottom. The other variation is in the magnification system as described below. The instrument with illumination system at the top can be tilted about a horizontal axis so that light is projected up or down at an angle. In the other the light is projected horizontally at all times. Pictures of the two slit lamps with the parts labelled are shown in Figures 8.1.

The Illumination System: The illumination system gives a well defined bright streak of light with sharp edges. The slit width is variable. The slit can be tilted as required. It has a source of light, a filament lamp or a halogen lamp used in some models for brighter light. The position and orientation of the filament is very important to avoid the image of the filament in the light projected from the illumination unit on to the eye of the patient. In some models there is a provision for tilting the illumination system forward through an angle of 20 degrees in steps of 5 degrees.

The electrical connection for the lamp is just a series connection through switches and pilot lamp. The voltage supplied to the bulb is adjustable in two or three steps. This is done by turning a knob, designated as brightness control knob (The brightness may have two steps low or high, or three steps low, medium and high). There is a main switch for the slit lamp. The pilot lamp glows when the power is turned on.

The Magnification System: The Biomicroscope is a stereo microscope that provides a stereoscopic view of the object (part of the eye) under focus, which is achieved by moving the microscope towards or away from the object after ensuring that it is at the proper height. The microscope is always focused on the slit image formed by the illumination system.

- ▶ (Inclined optics) The most common type has the axis of the two tubes forming the stereo microscopes inclined at 13° to each other, which constitutes essentially two microscopes, each with its own objective. There are usually two sets of objectives available for two different magnifications. The switching from one objective to another can be done with a small handle provided near the objective.
- ▶ (Parallel optics) In another type, two beams of light are picked from two diametrically opposite points of objective lens and two parallel beams are taken through two apertures in the instrument. In such instruments, with combinations of two pairs of lenses, forming a galilean telescope, and a rotating device, five different magnifications can be achieved. The eye pieces generally give a magnification of 10X or 12.5X. A second set of eye pieces with magnification 15X or 16X are usually supplied with the instrument.

The alignment of the optics in the microscope generally remains unaltered as long as the microscope is not subjected to a mechanical or thermal shocks. If the alignment gets disturbed it is a specialist's job to set it right. A rod is provided with the slit lamp to be used as object while carrying out the alignment of the microscope.

Mechanical System: This consists of three major parts.

Part I: This includes the table on which the slit lamp is mounted. The table is provided with castor wheels for ease in moving the equipment from one location to another. The castors also have a locking mechanism to fix the equipment in a location. A manual or motor driven mechanism is provided for the movement of the table top up or down. Motor driver one is activated using a hand or foot switch. The transformer mentioned earlier is fixed to the table. A drawer is provided in the table for storing the extra eyepieces and other accessories.

Part II: A chin rest mounted on a vertical stand is provided for placing the patient's head in the correct position. A head rest with a head band is available for securing the patient's head to the stand if necessary. The height of the chin rest could be adjusted manually to bring the chin rest to the level of patient's chin.

Part III: A joy stick (a lever) is provided to move the illumination system and the microscope together up or down, left or right, forward or backward as needed during observation.

Besides these, the illumination system alone can be rotated relative to the microscope and also tilted to provide the light from different directions for the observation.

Proper use and tips for optimum performance & long life: In a slitlamp, it is the bulb that fails most frequently. These bulbs, are very expensive and are also not readily available. The following precautions can help in prolonging its life:

- ▶ The bulbs used are usually of low voltage and a suitable transformer is provided with the slit lamp. There are generally three voltage settings available in the transformer at the output side. It is always advisable to use the transformer in its lowest setting for most of the observations, and use the higher settings sparingly for brief periods for more detailed examination especially under larger magnification and returns back to lower setting immediately after examination.
- ▶ When a series of patients are to be examined, keeping the illumination at low level during the change over of patients is better than turning the illumination off and on.
- ▶ Moving the slit lamp from one location to another should be avoided when the bulb is on or is still hot after it is turned off. A hot filament subject to jerks would break off more readily than a cold filament.
- ▶ If the place is subject to frequent voltage fluctuations, it is advisable to use a voltage stabilizer.

Operating environment: The slit lamp will have to be located in a place easily accessible to the doctor in the examination room. The fact that some of the patients may be severely handicapped and they may accidentally bump on the equipment is to be taken into account while planning the layout and the movement of the patients and the staff. An electrical plug point should be available near the equipment. The connecting wire should not be in the path of the patients and staff. The location should also be such that the equipment is not exposed to the heat of direct sunlight, or the full blast of chill air near an air conditioner.

User level care & maintenance:

- ▶ Remove the dust and clean the slit lamp daily. The microscope is generally sealed well and as long as the seal is not broken, dust cannot enter the microscope. Dust on the front surface of the objective and rear surface of the eyepiece should be removed gently following the instructions for cleaning optics given elsewhere in this manual
- ▶ When not in use keep the equipment covered with the dust cover (if not provided, a simple cover can be made out of cloth or polythene)
- ▶ The optical parts of the microscope may get the growth of fungi if the instrument is not properly cared for. The instruction for care against growth of fungi on optics described elsewhere in the manual should be followed. Humidity helps the growth of fungi. It is important to keep a bag of desiccating agent like silica gel in a bag within the dust cover of the instrument when the instrument is not in use. Also it is important to remove the instrument away from the room if the room is to be washed and is likely to remain damp for some time.

Preventive maintenance:

Care of the slit: A knob or a knurled wheel is available for varying the width and height of the slit and also for opening the slit completely. Also with the slit completely open, one can get circular spots of light of different sizes. The knob or wheel is spring loaded and the adjustment of the load is such that the motion of the knob or wheel is not too tight or too loose. Gently lubricating the movable parts is part of preventive maintenance. Too tight a motion will lead to greater wear and tear while too easy a motion will be frustrating for the user.

Care of the filters: The slit lamp has a disc that carries some filters that can be brought under the slit. The filters are to be treated like the other optical elements of the instrument and cleaned as described in Chapter-2.

Care of lenses: The condensing lenses between the bulb and the slit, as well as the focusing lens between the slit and the exit, and the front silvered mirror or total reflecting prism used for directing the beam towards the subject of the illumination system, need cleaning when the brightness of the light output is low. After removing the lenses, prism or mirror and cleaning them, follow the procedure for cleaning lenses described in chapter 2. They should be replaced in their proper setting as they were before removal. Condensing lenses may not have the same curvature on either side. It is important that the lenses are positioned correctly so that the slit image is free from aberrations produced by lenses.

Preventive maintenance schedule: Suggested frequency once a week

Check list for preventive maintenance:

- ▶ Does the table top move up and down freely?
- ▶ Does the chin rest and head rest move freely in the stand?
- ▶ Does the joy stick function properly?
 - Up and down motion
 - Forward and backward motion
 - Left and right motion
- ▶ Is the bulb turned on when the switch is on?
- ▶ Does the brightness of the slit vary when the brightness control knob is operated?
- ▶ Does the mechanism for varying
 - the slit width function smoothly?
 - the slit height function smoothly?
 - the inclination of the slit to the vertical function smoothly?
- ▶ Does the mechanism for opening the slit completely and bringing in the various circular apertures function smoothly?
- ▶ Does the mechanism for rotating the illumination system function smoothly ?
- ▶ Does the mechanism for tilting the illumination system function in instruments where this facility exists?
- ▶ Is the image of the slit projected on a piece of paper held at the chin rest stand seen clearly in the microscope?
- ▶ Is the slit image bright?

The answer for all these should be “yes”. If not, action is to be taken as described under trouble shooting.

Troubleshooting & Repair:

Mechanical faults: Any one of the movement listed above may not be smooth. This can be removed by cleaning and lubricating the parts concerned. If the joy stick is not functioning properly, the illumination and magnification systems are to be removed first. The slit lamp should be removed from the table top. The screws holding the slit lamp with the table can be accessed from the bottom of the table. The recess in which the joy stick operates will be seen when the slit lamp is turned upside down. Cleaning and lubricating the recess and tightening the nuts in the assembly will make the joy stick function effectively.

Bulb not glowing:

- ▶ Turn off the power and remove lamp housing cover.
- ▶ Remove bulb (do not touch with bare fingers).
- ▶ Check continuity of the bulb with a multimeter.
 - If bulb is fused, replace it.
 - If continuity is present, check the contacts for the bulb in the lamp housing, clean and tighten it, if necessary. Refit the same bulb.
- ▶ Turn on the power and check if the bulb glows.
 - If not, check the electrical system.

When the bulb is replaced, care should be taken not to leave any dust or thumb impression on the bulb. Halogen bulbs should not be touched at all with bare fingers. Any oil or grease left on the halogen bulb, which is usually made of quartz, would diffuse through quartz into the bulb reducing its life. As a general rule, bulbs should be handled with tissue paper or with cotton hand gloves. This also applies to removing a bulb for replacement.

Fault in the Electrical System:

- ▶ Check the power at the wall plug using a multimeter or a line tester
- ▶ Check the fuse for continuity
 - If no continuity, replace fuse
- ▶ Check the continuity in the connecting wire from the pins of the plug to the input end of the transformer using multimeter
 - If there is discontinuity, replace the plug and/or the wire
- ▶ Check the switches
 - If they don't function properly, replace them
- ▶ Check the voltage of the output with the power turned on
 - If there is no voltage replace transformer; you may have to ask the supplier for a replacement of transformer
- ▶ Check the continuity in the connecting wires from the transformer to the bulb socket
 - If there is discontinuity, replace the wire

Strategic spares & estimates of annual consumption under normal conditions: A spare bulb and fuse should be kept within immediate reach for quick replacement to avoid discontinuity in patient care. The supplier normally provides the following spares:

- ▶ A set of eye pieces
- ▶ A mirror set
- ▶ Bulb & Fuse

Minimum recommended stock of bulbs is two per slit lamp. When one is used, it must be replenished immediately.

Calibration/Quality control: After performing preventive maintenance or rectifying a fault, the slit lamp's overall functioning must be checked to see whether it is satisfactory. While it may be difficult to establish objective standards and measurement methods, the following should be done:

- ▶ check the light intensity using a suitable meter
- ▶ check mechanical movements
- ▶ be present by the doctor during slit lamp examination and ask for feedback on illumination, magnification & movements.

When to call an expert?: Most problems in a slit lamp can be handled at the institution level. However, the following conditions warrant the services of the supplier or an expert:

- ▶ when the optics in the magnification system are dislodged or become misaligned
- ▶ extensive damage due to optical and mechanical systems (e.g. by the slit lamp being toppled over)

Tools needed:

- ▶ Multimeter
- ▶ Screw driver set
- ▶ Wrench set
- ▶ Allen key set
- ▶ Optics cleaning supplies

CHAPTER - 9

Other Optical Equipment

There are some optical equipment which by their construction and usage require much less user level attention than the instruments described earlier. They are grouped in this chapter.

Keratometer: It is used to measure corneal power of the eyes. A picture of a keratometer is as shown in figure 9.1. The telescope like part (T) of the equipment can be raised or lowered by timing a knob (K1). It can be turned left or right manually by rotation around a vertical axis and fixed in any desired position by turning a knob (K2). Small left right movement in this fixed position is possible by turning another knob (K3). The telescope like part (T) of the equipment can be turned around a horizontal axis by hand. The angular position can be read on a circular scale (S). Knob (K4) is used for focusing on the cornea. While making the measurements, two drums (D) provided on either side of the equipment are turned to get the coincidence in the pattern seen through the telescope. The drums are calibrated in diopter units of power of the cornea. The instrument has a bulb that provides the necessary illumination. A chin and head rest are provided in the equipment for use by the patients. Keratometers of different manufacturers look alike.

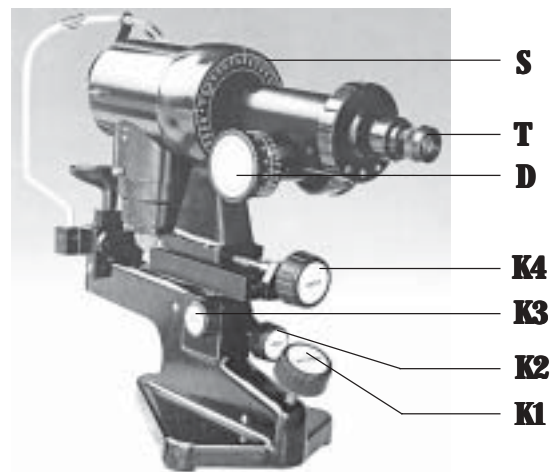


Fig. 9.1 Keratometer

User level care and maintenance: Remove the dust and stain on the equipment including the optical parts and external surfaces, only as described in Chapter 2. When not in use, turn the power off and keep the equipment covered. Occasionally when the power is turned on, there may be no light. The bulb may have ‘fused’ or there may be some fault in the electrical system. For this, the procedure described for slit lamps (Chapter 8) may be followed. Besides keeping the instrument clean, other important maintenance work will be to lubricate all moving parts so that movement of all the knobs and drums is smooth.

Checking Calibration: A set of three electroplated standard balls of precisely known radii (corresponding to known corneal powers) are available. Any one of the balls may be used to check the calibration of the keratometer. In case the drum reading is different from the known power of the steel ball, the screw holding the drum is to be loosened, and the drum set at the correct reading and the screw tightened again. The calibration may be verified using the other two steel balls.

Strategic spare:

- ▶ A spare bulb

Tool and supplies needed:

- ▶ Small screw driver set
- ▶ Allen wrench set
- ▶ Lubricating oil
- ▶ Optics cleaning material
- ▶ Multimeter

Lensometer: It is used to measure the focal powers of lenses (spherical, cylindrical and spherocylindrical) It can also determine the decentration in the lens. There are two generic models of the instruments. One in which the target seen through the eyepiece of the instrument consists of a number of bright points forming a circle, and another in which the target has a set of three wide lines with wide spacing between them and another set of three narrow lines with smaller spacing between them. These two sets of lines intersect at right angles. The equipment comes in different shapes. A picture of a typical lensometer, also known as focimeter, is shown in figure 9.2. The equipment has a clamp (C) for mounting the lens whose power is needed. There is provision for making ink dots on the lens at the desired points. For measuring the power of the lens, a calibrated disc (D) is turned till a clear and sharp image of the target is seen through the eye piece (E). For measuring the focal power of cylindrical and spherocylindrical lenses that have different powers in different meridians, the optics of the equipment can be rotated around the axis. The angular position can be seen on a circular scale(s) on the instrument.

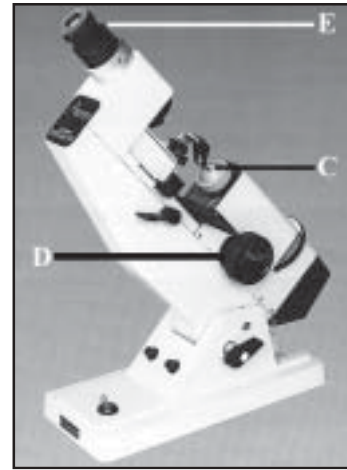


Fig. 9.2 Lensometer

User level care and maintenance: Removal of dust and stain, if any. Cleaning the optical surfaces at the front and rear end lubrication of moving parts and keeping the equipment under cover when not in use are the user level maintenance functions. Checking the bulb and electrical faults if any, when the bulb in the instrument is not glowing when turned on, is another maintenance function to be carried out as described earlier. The maintenance function exclusive for this equipment will be keeping the ink pad moist.

Strategic spares and tools: Same as in the case of keratometer.

Microscopes: There are two types of microscopes in use: (1) Laboratory microscopes (ii) Operating microscopes. Though the physical principle is the same, they have some major differences. Laboratory microscopes have different objectives that are moved in position for required magnification. In operating microscopes, the objective remains fixed but the magnification is changed using either a 3 or 5 steps magnification changer, or using a zoom set up that gives a continuous change in magnification. The working distance, the distance between objective and the object seen, is very small, almost zero for a laboratory microscope and can be as high as 200mm in an operating microscope. The magnification is relatively small (2 to 20) in an operating microscope, while it can be several thousand times in a laboratory microscope. Magnification can also be changed by changing the eyepieces in all microscopes.

User level care and maintenance: Removal of dust on the body and careful removal of dust and stain on the external optics of a microscope is necessary. This is very important in a laboratory microscope that sometimes uses an oil immersion objective. In case the oil enters the objective and the image is not seen clearly, remove the objective, pour a drop or two of acetone into the objective and when the oil gets dissolved in acetone, pour out the acetone and shake the objective to make it dry. In the case of an operating microscope, the objective always gets a spray of some fluid during the operation. After the operation is over, wipe the objective surface gently with a swab of cotton soaked in distilled water. The eyepieces may be cleaned as for the slitlamps.

Care of Mechanical System: All mechanical movements should be checked periodically and gently lubricated. The castor wheels of a microscope stand should run smoothly. It will be good to replace them as a set when any one or more of the castors is worn out or sticky.

DON'T MOVE A MICROSCOPE WHEN THE LAMP IS ON. EVEN GENTLE VIBRATION MAY CAUSE THE FILAMENT IN THE BULB TO BREAK.

Care of Electrical System: The electrical system should be checked periodically. Any defect noticed, like a loose connection, damage to insulation in the electrical wires, etc., should be rectified immediately. The cooling fan should run smoothly. They should run in such a direction as to suck air out of the instrument. Some times due to some mistake in electrical connections the fan may run in the opposite direction and suck air into the instrument. This will result in dust getting into the instrument and should be avoided.

Section III

CHAPTER - 10

General Care of Surgical Instruments

Surgical instruments are generally used as a set. They are therefore referred to as the IOL set, Keratoplasty set, etc., depending on the procedure for which they are used.

Materials: The material used for most surgical instruments is stainless steel. One should remember that this does not imply that the material is stain proof or stain free. They get stain on them during usage. Two categories of stainless steel are used. One of them does not contain any carbon in it and it is highly stain resistant, however it cannot be hardened. The other has a small percentage of carbon and can be hardened. The former is used for making tools like forceps while the latter is used for scissors and cutting instruments. These instruments are given a surface treatment to resist corrosion.

Inspection: Care of the precision surgical instruments begins on the day it is received. On receipt, each piece should be carefully removed from the container and examined under a microscope or a magnifying loupe. Defective ones should be returned for replacement.

Cleaning: Thorough cleaning, rinsing and drying will significantly improve the life of the instruments. Some useful tips are:

- ▶ Do not allow medicines, irrigating solutions, tissues, blood, etc., to get dried on instruments. Immediately after surgery, the set should be rinsed in distilled water, including the instruments of the set which have not been used.
- ▶ Only mild soap and a soft brush, like a tooth brush is to be used for removing the more sticky stains not removed in the earlier step. Joints, locks and serrations in the instruments must be cleaned well. It is in these locations, that corrosion starts.

DO NOT USE METAL BRUSH, STEEL WOOL OR ABRASIVE POWDER FOR CLEANING. THEY WILL DESTROY THE SURFACE FINISH ON THE INSTRUMENT AND LEAD TO CORROSION

- ▶ The instruments are to be dried well by aeration or preferably by hot air. They should not be wiped with a cloth as it may damage the surface finish and the sharpness. They also leave a lint which is not desirable during surgery.

Ultrasonic cleaning: The best method for thorough cleaning of surgical instrument is by using an ultrasonic cleaner. Here, high frequency sound waves dislodge tissue and other particles adhering to the instruments, while it is soaked in distilled water or in the recommended solution. This procedure is recommended for all surgical instrument at the end of the days work. While keeping the instruments in the baskets for ultrasonic cleaning, one must make sure that instruments do not touch each other. After cleaning, the instruments are to be dried in hot air.

Lubrication: All moving parts, joints, locks and catches are to be lubricated after each cleaning. Only those lubricants like silicone or teflon spray that can withstand high temperature of autoclaving are to be used.

NEVER USE ORDINARY LUBRICATING OIL

Before lubrication, it is absolutely essential that the instrument is stain free at the lubricating points. Otherwise the lubricant would cover the stain and form a protected sheet for corrosion to begin.

Sterilization: This is not cleaning. Instruments should be thoroughly cleaned before sterilization. Stainless steel instruments can be sterilized by steam autoclaving, chemical disinfectants, ethylene oxide gas or even dry hot air, as available at the hospital. Follow the manufacturer's instruction for sterilization of a particular instrument or its parts.

Storage: The instruments are generally stored in special trays available for each set. Each instrument is firmly seated in the tray to prevent movement. While sterilizing the instruments the entire tray is sterilized. Delicate knives, hooks and spatulas are placed in built-in stainless steel rack for additional protection. Special instruments like diamond knives should always be stored in a special container.

Sharpening: Sharpening of cutting edges of scissors and knives may be carried out using fine polishing stone under examination through a low power microscope. The operating microscope may be used for this purpose if a separate microscope is not available.

Transportation: When surgical instruments are to be transported especially for camps outside the hospital, the tools should be wrapped individually and sharp edges should be properly covered.

CHAPTER - 11

Care of Knives

Care of diamond knife: Diamond is the hardest of all materials. No other material can cause a scratch on diamond. For this reason, diamond knives have a long cutting life. When the blade is not in use, it should be retracted into the handle.

Cleaning: Clean the blade immediately after use with a flush of distilled water through a syringe. A surgical sponge moistened (never dry) with distilled water is to be used for gently wiping the edges and sides of the blade. If the stain on the knife cannot be removed with distilled water, a sponge moistened with hydrogen peroxide may be used. Wiping should always be in the direction towards the edge and never in the opposite direction (see figure 11.1).

Sterilization: The diamond knives should be kept in the special trays provided for the purpose of sterilization. Thorough cleaning is a must before sterilization here also, as any organic matter will get baked on the diamond during sterilization.

Sharpening: Diamond knives have to be returned to the manufacturer for sharpening. For safety during transit, always use the special container.

Storage: Store in the special container provided along with the diamond knife.

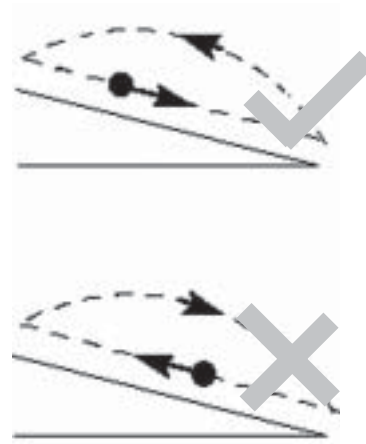


Fig. 11.1 Showing the direction of movement of the cleaning sponge for diamond knife - right and wrong ways.

APPENDIX - I

Multimeter

Multimeter is a very useful instrument for a technician while checking electrical/electronic parts of any equipment. Most of the time it will be used to measure voltages (direct and alternating), for measuring resistances or for checking continuity in wires and circuits. It can also be used to measure electric current.

Types: They are of two types. The most common and relatively inexpensive one has a meter with a needle and is known as analog multimeter. The other one known as digital instrument has digital display. The reading appears as a set of numbers.

Digital instruments need batteries for working in all the ranges. They must be turned off when not in use to ensure long life for the batteries. Analog instruments use batteries only in the resistance ranges. When not in use, they should not be left in the resistance range so as to avoid any accidental short circuit and discharge of the battery.

Taking reading in an analog meter: Any multimeter has several ranges, over which measurements are made. The ranges are marked on the scale. The instrument is also used for multiples of ranges marked on the scale. The scales and the reading corresponding to each sub division in the scale should be well understood.

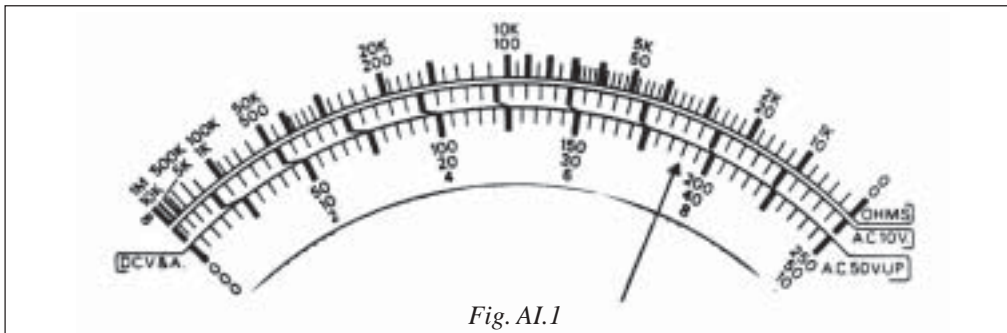


Fig. AI.1

If the needle stands in the position as in figure AI.1, the corresponding readings in the different ranges will be as follows:

Range	Reading	Each small division corresponds to
0-10	7.6	0.2
0-50	38.0	1.0
0-250	190.0	5.0
0-500	380.0	10.0
0-1000	760.0	20.0

In analog instrument there is always a danger of damaging the instrument if the instrument is not used at the proper range.

CAUTION: WHEN YOU ARE IN DOUBT, IT IS SAFER TO START WITH THE HIGHEST RANGE AND THEN MOVE TO LOWER RANGES TO GET A GOOD DEFLECTION OF THE NEEDLE.

Digital instruments have some protection. They are of two types. They change from one range to another or indicate overload. They also have a fuse for protection.

Testing Continuity: When there is any discontinuity in a connecting wire and between certain points in a circuit, there is large resistance. This can be checked using the resistance range. Put the probes of the multimeter on the points between which continuity is checked. If the resistance reading is zero or a very low value in a digital meter or the needle moves to the extreme right in analog meter, there is continuity. Some instruments give a beep signal when there is continuity; and if otherwise there is no continuity.

Measurement of resistance: The resistance measurement scale in the analog meter is different from the current and voltage measurement scales. The zero of the scale is in the extreme right. The readings are not evenly spaced. They are more crowded at the left, than in the right. The first step in measurement of resistance is to short circuit the probes and adjust the knob provided for the purpose, till the reading is zero. Then touch the two ends between which resistance is to be measured and take the reading.

Care and maintenance: The probes of a multimeter may develop discontinuity. So check the continuity of the probes when in doubt. An easy way to test this is to check the resistance as described above.

Make sure that the instrument is set on the proper range before measurement. For example, after measuring resistance or current if the instrument is used for measurement of voltage without setting the instrument on the proper voltage range the meter may be damaged. Some instruments may have overload protection and so the fuse inside the instrument may be blown off.

APPENDIX - II

Optical Surfaces

Surfaces of optical elements like lenses, prisms, mirrors, beam splitters, windows and filters used in optical instruments are specially prepared. They are highly polished. Any irregularities on the surface will be less than a fraction of the wave length of light. In addition, such surfaces have a thin coating of certain materials to get the desired functions. Surfaces of lenses, prisms and windows are usually given an antireflection coating to prevent loss of light due to reflection. This ensures maximum transmission of light through the surface. Mirrors have a highly reflecting coating to get maximum reflection of light. Beam splitters have a coating of special thickness to have a certain percentage of reflected light and the balance is transmitted through them. Filters have coatings to cut out undesired light. In the case of lasers, the mirrors used have several coatings to give a reflectivity as high as 99.95% or better for a given wavelength.

Scratches on an optical surface produce unwanted scattering of light. Dust particles may produce scratches if they are not properly removed.

OPTICAL SURFACES SHOULD NEVER BE WIPED BY HAND OR CLOTH TO REMOVE DUST ESPECIALLY WHEN IT IS DRY, - DUST MUST BE BLOWN OFF.

Sharp instruments, even sharp finger nails, may cause a scratch. One should be careful in using sharp instruments near optical surfaces when removing or refitting the optical elements. Holding the elements by their edge is important.

DON'T TOUCH OPTICAL SURFACES WITH BARE FINGERS.

Optical surfaces that require cleaning may be cleaned following the procedures described in Chapter 2. However repeated cleaning may wear out some of the coating described earlier and the property of the surface may change. "Prevention is better than cure" is an important rule with such surfaces. Keeping them protected from dust, stain and fungus is always better than trying to remove them more frequently.

APPENDIX - III

Some Simple Electrical Calculations

1. What is the current drawn by a 150 watt 15V microscope bulb?

Power (watt) = Volt x Current (amperes)

$$150 \text{ W} = 15\text{V} \times I \text{ (A)}$$

$$I = 150/15 = 10\text{A}$$

2. In the above example the current is supplied at 15V using a transformer. If the main supply is 220V, what is the main current?

Primary voltage x Primary current = Secondary voltage x Secondary current

$$220 \text{ (volts)} \times I \text{ (amperes)} = 15 \text{ (volts)} \times 10 \text{ (amperes)}$$

$$I = (15 \times 10)/220 = 15/22 = 0.7\text{A (approx)}$$

3. There are three microscopes in an operation theatre each fitted with lamps of the power given in example 1. They are all connected to the same plug board in the theatre.

What is the safety fuse for the theatre?

Each microscope draws a current of 0.7A from the mains. All three in total will draw a current of 2.1 ampere. A 5 ampere fuse which is very common may be used for the supply board.

4. If the supply board is connected to a voltage regulator what should be the rating of the voltage regulator?

The power drawn = $220 \times 2.1 = 462$ watt

Hence a 500 watt stabilizer could do the job. However a 1000 watt (1 KW) stabilizer is preferable for reasons given below.

The resistance of a coil of wire increases with increase of temperature. When a bulb is turned on it is cold at the beginning and its resistance is less. Therefore it draws more current than when the bulb is hot. For this reason the fuse and stabilizer ratings are always more than the calculated values.

APPENDIX - IV

Training Course

At LAICO, Aravind Eye Care System, Madurai six week training courses in the maintenance of Ophthalmic Surgical Instruments and other Equipment are held.

The Course objectives are

I. Organizational skills

1. Listing and keeping track of all equipment in the hospital.
2. Maintaining adequate stock of essential supplies for instruments (bulbs, fuses, paper rolls, etc.).
3. Developing procedures for keeping track of the entire maintenance process (care, maintenance and repair) including warranty and maintenance contracts.
4. Maintaining catalogues, instruction and service manuals of the instruments.
5. Training the users of instruments on the various DO's and DONT's.

II. General Maintenance skills

1. Trouble shooting and diagnosing the problems in instruments reported to be not working.
2. Rectifying faults that can be handled locally and properly communicating the problem as precisely as possible to the supplier/outside service agency.
3. Planning for maintenance activity in an eye-camp site away from the hospital.

III. Skills relating to maintenance of electrical and electronic instruments

1. Using multimeter.
2. Identifying components and knowing their characteristics.
3. Soldering and building simple electrical/electronic circuits.
4. Identifying electrical fuses in instruments and understanding their rating.
5. Calculating the power ratings of instruments to provide (i) proper fuses, (ii) proper transformer or voltage stabilizer or UPS as required.
6. Adapting a 110V instrument to work in 220V if the feature is built into the instruments.
7. Building a 220V-110V step down power unit with proper fuse.
8. Changing bulbs in ophthalmoscope, retinoscope, slit lamp, microscope, lensometer, keratometer and fundus camera.
9. Locating electrical faults in equipment like torch light, surgical lamp, foot switch, etc., and rectifying the same.

IV. Skills relating to maintenance of optical instruments

1. Cleaning optical surfaces (mirrors, lenses and prisms).
2. Dismantling, cleaning and assembling the following instruments: Ophthalmoscope (direct and indirect), Retinoscope, Slit lamp.
3. Carrying out preventive maintenance on other optical instruments: microscopes (operating and laboratory) lensometer, keratometer and fundus camera.

V. Skills relating to maintenance of mechanical parts of equipment

1. Locating and rectifying faults in castor wheels of equipment.
2. Locating and rectifying faults in movement of table tops of slit lamp, fundus camera and other instruments.
3. Lubricating necessary parts.
4. Sharpening and repairing surgical instruments.
5. Adapting damaged or worn-out surgical instruments for other use.
6. Checking the calibration and rectifying faults if any in Schiottz tonometer.
7. Checking leaks if any and fixing them and topping up mercury in BP meter.
8. Checking leaks, if any, in cryosystem and fixing the same.

VI. Relevant knowledge

1. Of eye and its parts
2. Of common refraction defects and the remedy
3. Of common eye diseases and their treatment
4. Of working principles of the following instruments that they will be handling
 - Ophthalmoscope (direct & indirect)
 - Retinoscope
 - Slit lamp
 - Microscopes (operating and laboratory)
 - Lensometer
 - Keratometer
 - Cryosystem
5. Of working principles of the other instruments that they may come across in the hospital
 - A & B Scan
 - Field analyser
 - Laser systems
 - Slide Projector, audio and video system

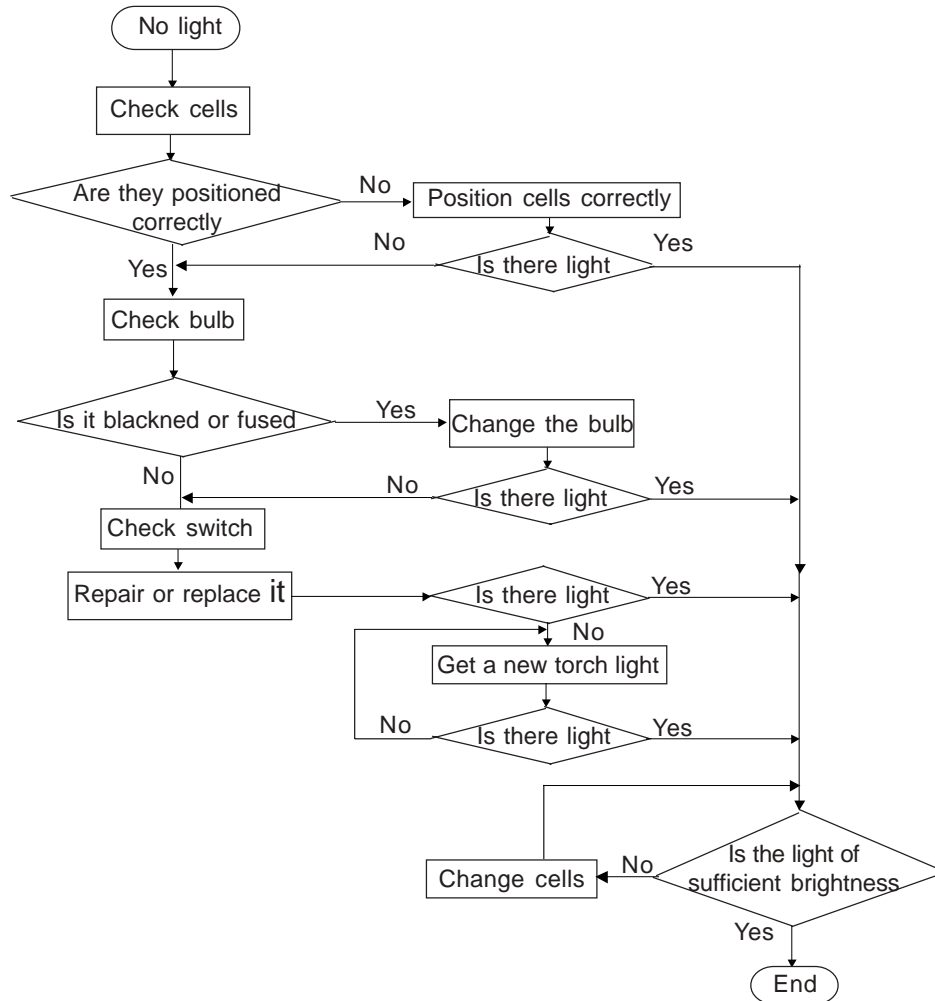
For effective training the trainee trainer ratio is 1:1

VII. Instruments Maintenance Camps: Towards the end of the course the trainees are taken to a hospital outside Madurai and are exposed to servicing the instruments in the host hospital.

Index

Care, defined	4	Fungus on optics	7
Care of		Indirect Ophthalmoscope	21
bulbs	9	Keratometer	37
cells	9	Lensometer	38
electrical ground	9	Maintenance	
electrical parts (general)	8	breakdown	5
foot switch	9	contract	5
fuse	8	frequency	5, 15
mechanical parts (general)	7	preventive	5
multimeter	44	records	11 to 15
optical parts	4, 45	terminology	4
painted surfaces	7	Microscope	
surgical instruments	40	laboratory	38
surgical knife	42	operating	38
Down time	5	Multimeter	43
Dust removal	6	Optical surfaces	45
Equipment		dust removal	6
assembling	8	stain removal	6
disassembling	8	fungus on	7
disposal	5	Ophthalmoscope	
electrical input	4	direct	19
folder	4, 10	indirect	27
installation	4	Resistance measurement	44
ordering	3	Retinoscope	24
withdrawal	5	Slit lamp	31
Electrical calculations of		Stain removal	6
power	46	Spares	
fuse	46	planning	4, 16
Focimeter	38	hardware	16
Fuse		Torch light	17
rating	4	Training course	47
calculations	46	Voltage measurement	43

Maintenance Protocol Flowchart Sample



Having a flow chart for maintenance protocol is always useful. An example to check the light output of torch light, ophthalmoscope or slit lamp is given above. It is expected that the users of this book would prepare similar charts for other protocols.

- Authors.

E-mail: instruments@aravind.org

PICTURE CREDITS

The pictures of instruments on the cover page and throughout the text are taken from the trade catalogues of those equipment. We wish to add that the pictures chosen are used to represent the instruments and not to advertise any product.

Cover design: Mrs. Chitra Thulasiraj

-Authors

laico

LIONS ARAVIND INSTITUTE OF
COMMUNITY OPHTHALMOLOGY

72, Kuruvikaran salai, Gandhi Nagar, Madurai 625 050, Tamil Nadu, India
Phone: (0452) 2537580; Fax: (0452) 2530984; instruments @ aravind.org
www.aravind.org