Technology for VISION 2020

Selected articles from the Community Eye Health Journal

VISION 2020
THE RIGHT TO SIGHT

INTERNATIONAL CENTRE FOR EYE HEALTH

Technology for VISION 2020

Selected articles from the Community Eye Health Journal

Published by
International Centre for Eye Health

With the support of
Christian Blind Mission International, Dark & Light Blind Care,
Conrad N Hilton Foundation, Stanley Thomas Johnson Foundation,
Sight Savers International, Tijssen Foundation

ISBN 1-902541-146

Published and distributed by
International Centre for Eye Health
London School of Hygiene and Tropical Medicine
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London WC1E 7HT, UK

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Web: www.iceh.org.uk

This collection was edited by Sue Stevens and Ann Naughton.

Designed by Regent Typesetting
Printed by Heyford Press

Contents

Preface

Disease control

Human Resources

Infrastructure and Technology

The material of this collection, *Technology for VISION 2020,* addresses one of the three key components of a VISION 2020 programme: affordable technology for the delivery of eye care. All of the articles come from the *Community Eye Health Journal* and most are attributable to the series that the Journal ran from 2002 to 2004 highlighting the need to share information and practical advice on a global scale. Additional material was drawn from other relevant Journal articles aimed at standardizing procedures and resources.

The chapters cover a range of requirements to ensure that properly resourced eye units support the aims of VISION 2020. This includes purchasing, stock control and care and repair of equipment and instruments; technology and practice for infection control in eye units; and equipment and training for low vision services. The collection includes articles, posters, and information on standard lists of equipment and consumables. It is intended as a handbook for those working in prevention of blindness programmes, providing easy reference for establishing appropriately resourced services and for teaching others.

The focus on infrastructure and technology for prevention of blindness work has been sharpened through the VISION 2020 initiative and, with continuous developments and more countries implementing VISION 2020 programmes, this area is likely to expand. The increasingly active VISION 2020 Technology Group provides a nexus for this, and without the proactive role they have played thus far, the collection in this publication would not have been possible. We are also most grateful to those authors who communicated their knowledge and experience in their contributions to the Technology for VISION 2020 series in the *Community Eye Health Journal.*

Victoria Francis
Editor, *Community Eye Health Journal*
June 2005

Technology for VISION 2020

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The Global Initiative for the Elimination of Avoidable Blindness (World Health Organization, 1997), which is VISION 2020's base document, emphasises the need for appropriate and affordable technology for the delivery of eye care on a global scale. The past ten years have already seen initiatives which have immeasurably increased access to eye care in developing countries. The outstanding achievement has been the mass production of low cost, high quality intraocular lenses, first by Aurolab in India, and then by the Fred Hollows Foundation. These organizations have substantially reduced the cost of IOLs, which are now widely distributed on the world market, and thus brought high quality cataract surgery within the reach of millions more people.

IAPB Technology for VISION 2020 Working Group

By 2001 working groups had formed to address VISION 2020 priorities such as low vision and refractive errors. However, it was only in October 2001 that the International Agency for the Prevention of Blindness (IAPB) decided to set up a working group on technology. This group met for the first time at a workshop on 26th and 27th April 2002 in Sydney, Australia, after the International Congress of Ophthalmology. Twenty four people representing 15 organizations attended.

The workshop's objectives were:

- To share information aboutcurrent availability of resources on appropriate technology for eye care
- To identify priorities fordevelopment, taking into account common needs and the resources available
- To agree the way forward.

The working group recognized the wide variation which exists between countries regarding norms and standards of eye care equipment, and committed itself to promoting the use of high quality equipment and consumables within national eye care programmes. Further, the group seeks to encourage the development of appropriate national standards and monitoring systems. A series of priorities were agreed by members of the group on which they will work over the coming year.

1. Establishing a purchasing network. It was agreed to set up an e-mail network among the procurement managers responsible for purchasing equipment and consumables for their organizations. The intention is to share information on the suitability of items as well as on issues such as freighting and customs requirements. Procurement managers interested in joining the network should contact Philip Hoare at Sight Savers International (phoare@sightsavers.org).

Learning to repair and sharpen instruments
Photo: Photography Department, Aravind Eye Hospital, India

2. Identifying equipment and consumables for development. It was recognized that further work needs to be done to identify low-cost items for development and how these will be developed. There was discussion over the increasing need for low cost lasers, particularly in the treatment of posterior capsule opacification after cataract surgery. The group felt that research was needed to determine the scale of need for treatment of PCO, as well as for angle closure glaucoma, and agreed that this should be followed up.

3. Achieving a common standard list of equipment and consumables. Several organizations have lists to assist staff and partners order suitable items. However, it was felt that these lists needed to be reviewed and consolidated. It would be helpful to include sections appropriate for setting up services at primary and at secondary level, as well as for training purposes. The list would need to be flexible and adaptable for regional differences, and, most important, information relating to suppliers and manufacturers should be included, with local maintenance and servicing facilities, and guide prices.

Providing an up-to-date service to eye care partners has major financial implications to which the group will have to give further thought. In the meantime, the International Resource Centre at the International Centre for Eye Health has offered to act as a collection point for existing lists, and for the collation of information on equipment maintenance (see below). *All technology group members, and readers of this article, are asked to ensure that copies of relevant information are* *sent to the Resource Centre, ICEH, at the address given in the Resources section.*

4. Providing service support, education and training. Aravind Eye Hospitals in Tamil Nadu, India have considerable experience in delivery of high quality services. Two colleagues from Aravind made presentations on the equipment requirements for high volume cataract surgery and on issues around servicing and maintenance. Many items of essential eye care equipment lie idle for lack of maintenance or, simply, spare parts. The working group agreed that in order to achieve the objectives of VISION 2020 and aid sustainability, it would be necessary to:

- Integrate equipment maintenance personnel into the eye care team and provide training
- Ensure that all eye care personnel achieve a basic understanding of the principles and practice of maintenance
- Increase the availability of training, information, and post-training support.

A short training course for maintenance personnel has been running at Aravind four times a year for several years and Aravind has facilitated the establishment of a similar course in Kaduna, Nigeria. A different model, of itinerant service personnel, exists in Pakistan and may also start in Kenya. Nevertheless, this represents a fraction of the need, and the working group agreed that ways have to be found to expand maintenance training. One idea is the establishment of 'technology centres'.

5. Distribution networks. How often do we find that eye care personnel are hampered by the lack of appropriate and functioning equipment? Ministry of Health eye units, as the end users, often have little or no influence over the ordering and procurement process. This leads to problems such as inappropriate, incomplete, non-standard items being received, so that the equipment is unusable, the ophthalmic personnel cannot work effectively and their morale suffers, as indeed do their patients.

The working group considered the feasibility of a network of regional or national technology centres which could facilitate:

- Bulk purchasing of agreed high volume items
- Advocacy for the registration of essential items not yet included on national Essential Drugs and Appliances lists
- Importing procedures, storage,maintenance, and distribution.

While recognizing the difficulties of making this concept operational, the group agreed to investigate it further to see whether it would be workable in one or more countries.

These were some of the key issues discussed by the IAPB Technology for VISION 2020 Group. They recognized that improving access to appropriate equipment and supplies is vital to the development of eye care services and the ultimate success of VISION 2020. The group acknowledged that more can quickly be done to make available existing information through the e-mail purchasing network, and potentially through the ICEH Resource Centre. However, some of the other proposals, such as the development of information on the internet, have financial implications which will take time to resolve. We hope to bring readers progress reports in future editions of the Journal.

First published in *Community Eye Health* Vol. 15 No. 42 2002; pp. 17–19.

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Purchasing and stock control for eye care units

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This article aims to provide guidelines in support of the Infrastructure and Technology component of VISION 2020.

Purchasing and stock control play an important part in effective project management and coordination. All efforts are wasted if necessary supplies are unavailable.

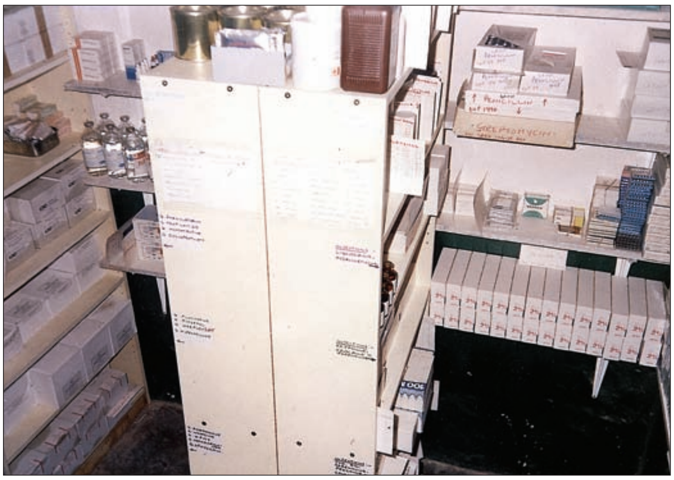
- Patients willingly travel to a hospital that is reliable and has a well-established reputation, but will not attend an eye unit that cannot dispense their medication on discharge or will cancel their operation because a replacement microscope bulb cannot be found
- Staff will soon become demoralised seeing 'out of stock' written in order books or on store shelves and, more importantly, patients will suffer
- The effect will not only be felt by the hospital staff and the individual patient but will have far-reaching consequences, outside of the hospital, for the community it is aiming to serve.

Deciding What is Needed

Each department needs to decide what supplies are required. The following list will help to identify which supplies are already held and which extra items may need to be ordered and kept available in the store.

- **Routine consumables:** e.g., syringes, needles, gloves, IOLs, eye drops, other medications
- **Specialist items** : e.g., vitrectomy tubing, paper for A-scan biometry, Schirmer's test strips, intra-vitreal antibiotics, sutures for plastic and retinal surgery, anti-fungal pellets, instruments for specific surgical training
- **Bulbs** for routine equipment: e.g., slit lamps, direct and indirect ophthalmoscopes, lasers, lensometers, operating lights
- **Spare parts** for routine equipment needing regular and frequent maintenance: e.g., fibre optic cables for microscopes, spare keys for lasers, foot pedals for microscopes, A-scan probes.

Needs should be discussed with staff members who know their department well and clear explanations given regarding what they hope to achieve through good stock control practice. When supply needs are decided the information can be collated and a stock control policy devised.



Pharmacy store – labelling and displayed lists assist easy access
Photo: Sue Stevens

Establishing a Stock Control System

A person of integrity should be appointed as the store keeper. The system should be clearly explained and the importance and responsibility of their role emphasised. Supervised practice is necessary in the early days following the appointment.

Stock Cards

Each item in store, e.g., medical drug, spare part, stationery item, should be entered on a dedicated stock card. These cards:

- Can be either hand-written or be stored in a computer; the important factor is accuracy
- Show a running balance of the quantity of the specific item
- Can be maintained by the store keeper who is responsible for entering the quantity issued and the requesting department on the card
- Should be checked each month by someone in authority to ensure accuracy and also to enable monitoring of the general usage in each department.

Noting the monthly usage is useful when considering the annual budget and requirements for the year ahead. An end-of-year stocktaking exercise is required for correct auditing procedures.

Minimum Stock Levels

The heads of department will indicate the minimum stock levels required for each item based on the quantities required for maintaining a service. This figure is entered on the stock card. It needs to be taken into consideration whether an item is a local or overseas purchase. Orders need to be placed well in advance of the minimum stock level being reached. At least two months working supply for local purchases and 6 months for overseas purchases is recommended. Forward planning is important as holiday times will affect the processing of orders from the suppliers. If the Unit has students in (surgical skills) training, allowance should be made for extra use of certain items, e.g., sutures and visco-elastic.

Identifying and Accessing Stock

Storage Suggestions

- Storage conditions are a vitally important consideration in hot humid climates. Air conditioning may be necessary as most drugs need optimum storage conditions. Medications and other consumables can be stored alphabetically for ease of access
- Frequently used items, e.g., bulbs, spare parts and surgical instruments are best kept in a central place within the department where staff who are familiar with them and understand their functions can quickly access them and order as stock levels demand
- Specialist equipment and expensive materials should be stored in a secure place in the store where access is limited
- Anaesthetic equipment should be stored in a designated area
- Displayed lists and colour-coding of shelves will provide easier access
- Food, stationery and cleaning materials must always be stored separately and away from medical equipment.

Developing a Purchasing Policy

It is the responsibility of the management team to devise and establish a purchasing policy based on the priority needs for consumable and non-consumable items as identified by the departmental staff.

Depending on individual and local practices the policy will vary but basic principles of accounting and auditing should be followed.

Purchasing Procedure Suggestions

- Maintain a register with up-to-date names and contact details of all suppliers used. List what each supplier provides and the costs
- Request an updated price list and catalogue each year. Copies of these may be kept in the finance department and stores for reference
- Try to keep the number of suppliers to a minimum. This may be difficult especially regarding specialist items ordered from overseas
- Purchase local items on a monthly or weekly basis. If possible, organise group bulk purchasing with other eye units to reduce costs. A 30-day credit facility is useful when using local suppliers
- When the orders have been prepared they should be passed to the person responsible for estimating the cost, e.g., the department finance manager. With available funds and no outstanding debts with suppliers confirmed, the order can be presented with the relevant stock card showing the current balance for approval by management and the order placed with the supplier.

Receiving Purchased Items into the Store

The purchases will arrive with an invoice or a delivery note and should be checked into the store by the store keeper or other responsible person appointed to this particular task. A ‘goods received note’ (GRN) should be completed and the date and quantities received entered on the stock card to give a running balance. This entry should be signed by the person receiving the goods. All invoices, delivery notes and GRNs should be sent for final checking by the finance manager before cheque payment is made.

Considerable financial investment is necessary when stocking an eye unit and this is an important reason for creating an efficient and effective purchasing and stock control system. Unnecessary ordering, especially items that will become out-of-date is wasting money. Emergency orders and delays in service delivery will eventually increase the cost of surgery. Items purchased locally will help to maintain the low cost of cataract surgery. Consistently good quality materials are important to both the surgeon and the patient.

Health care budgets are already stretched. We have a responsibility to manage donors’ and patients’ money carefully. Well-maintained stores and effective purchasing policies will enable the provision of affordable eye care for the community as a whole.

First published in *Community Eye Health* Vol. 16. No. 45 2003; pp. 9–10

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Training in the care of equipment and instruments

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Modern health care, eye care especially, is very much dependent on the use of technical equipment and instruments. These are expensive, more so in developing countries. Much of the quality equipment and instruments are made in developed countries and, even with normal and careful use, are subject to wear and tear. It is important to take good care of them and employ preventive maintenance to keep them working at all times. The 'down time', if any, during which an instrument or equipment is not working should be reduced to a minimum.

We seek to answer the following questions by sharing our experience at Aravind Eye Care System in Madurai, India.

- *How can these objectives be achieved?*
- *Which methods will achieve these standards?*
- *Who can carry out these tasks?*

Maintenance, Methods and Tasks

1. **Understanding the correct use of the instrument**. Instruments manufactured by well-established manufacturers and marketed by equally established suppliers are generally well made and strong. They seldom fail when used properly and with care. When instruments fail there is always some reason for the failure. Knowing how or why a failure has occurred is an important maintenance task. Without knowing the cause of a failure it will not be easy to fix it. Reading and understanding the user manual that comes with the instrument is essential for this task.
2. **Understanding the limitations of the instrument**. Every instrument, by its design and construction, has some limits to its operations. Some can handle only a certain load at a time. Some can work only within a certain speed. Some have certain limits relating to environmental conditions (temperature, humidity etc.) for proper functioning. Some have certain limits of mobility when in use. It is important that these limits are well understood and remembered when the instrument is used. Instruments should, as far as possible, be used only within the prescribed limits of operation. Using an instrument to its maximum limit should be more an exception than a rule.
3. **Carrying out preventive maintenance.** In health care it is well understood that prevention is better than cure. This also applies to both instruments and equipment. Periodic preventive maintenance is needed for trouble free performance. This includes protecting them from dust and stain, and checking and lubricating all moving parts to ensure smooth movement. It is vitally important to ensure that there is no 'kink' (bend) or obstruction in the tubes and valves of equipment that use some flow of fluid. The various other preventive maintenance tasks, specific to each piece of equipment, are explained in the user manual which should be read and the instructions carried out.

A training session
Photo: Photography Department, Aravind Eye Hospital, India

4. **Replacement of spares**. Almost all items of equipment have certain parts that have a finite life. The bulb in instruments may be fused out ('blow'). The electric fuse may be blown off. The belt, springs or wheels used to drive some part of the equipment may snap off or become loose or may be displaced or may be exhausted. An adequate stock of all spares is always required. Identifying faults and defects and knowing how to restore good function is important.
5. **Care of electrical parts**. Almost all equipment uses electricity for operation. Simple electrical faults external to the equipment, like a damaged plug or switch, a short circuit or discontinuity in the connecting wire are not uncommon. Locating those defects and rectifying them is another maintenance task.
6. **Care of optical parts**. Many pieces of equipment used in eye care have lenses, mirrors, prisms, reflectors, etc., which have surfaces of high optical quality and some of the surfaces may also have special coating for specific needs. Protecting those surfaces from dust and stains and removing dust and stain without causing any scratch or any damage to the coating is an important part of preventive maintenance.
7. **Aligning optics**. Even slight displacements of the positions of optical components affect the quality of the images seen when using them.

8 **Care of surgical instruments**. Taking care of the surgical instruments, sharpening the edges when necessary and repairing them when damaged are essential.

Who can carry out these tasks? A qualified bio-medical engineer can probably do all these. However, such persons are not readily available, especially in developing countries. The tasks require a wide range of skills but the technology required is not very complex or difficult. Our experience is that an assistant in an eye hospital (perhaps an electrician, an ophthalmic nursing assistant or a refractionist), who has some interest in working with his/her hands, can be trained to do all the above tasks and even more.

Selection of Technicians

At Aravind we recruit polytechnic graduates. They have two or three years of engineering education and training beyond high school. With some extra on-the-job training in our instruments maintenance laboratories they are able to carry out all the tasks described above and also teach others. We have found from our experience that women will often do a better job then men! Technicians at Aravind also make spare parts for some instruments and are also encouraged to build simple equipment used in eye care.

Equipment and Instruments: Maintenance Courses

The six-week maintenance courses run in LAICO (Lions Aravind Institute of Community Ophthalmology), Aravind Eye Care System, Madurai, India aims to teach the skills needed for equipment and instruments maintenance. The courses have been organised since 1996. As of this date, we have conducted 27 such courses, training 151 technicians, including 20 women. Thirty-seven technicians (almost 25%), including 2 women, are from 14 developing countries outside India - Jamaica, Ghana, Nigeria, Uganda, Kenya, Malawi, Zambia, Zanzibar, Pakistan, Philippines, Nepal, Papua New Guinea, Indonesia, and Bangladesh. (See useful resources section)

A technician making a spare part (bulb of a slit-lamp)

Photo: Photography Department, Aravind Eye Hospital, India

Equipment and Instruments: Maintenance Camps

Towards the end of each training course the trainees, accompanied by some of the instructors, spend a few days in a hospital outside the Aravind Eye Care System and run a free maintenance camp. Such camps benefit the trainees who come across different types of equipment and instruments with different problems. The host hospital benefits because their needs in maintenance are taken care of by the trainees.

One important feature of the Madurai courses is that the trainees are supplied with a set of hand tools so that they can start their work immediately, on reaching their hospitals after the training. We have received good reports of the work of several of the technicians trained at Madurai.

Technician Trainer's Course

Following the basic six-week course, we offer a trainer's course. Persons taking up this training will be able to organise similar training courses in their own work places. The West African Health Community has taken advantage of this and three technicians from that region underwent the trainer's course. With these technicians and two more technicians trained in earlier years as additional hands, a training centre was established in Nigeria. Two persons from Aravind were invited to Nigeria to take part in their first training course run in September-October 2000. Subsequently, the West African team has run two more courses. One of the technicians from Nigeria has established a maintenance facility in his home town, servicing ophthalmic and other medical instruments and employing others. A technician from Pakistan, trained in Madurai, is running a technician training course in his country.

First published in *Community Eye Health* Vol. 15 No. 43 2002; pp. 43–4.

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The maintenance and repair of ophthalmic surgical instruments: training at the eye clinic

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Ophthalmic microsurgical instruments are delicate and require special care. In developing countries, where instruments are usually difficult to replace, maintenance and repair are even more important. The Jan Worst Research Group started a project in 1994 - after several requests for assistance in the repair of ophthalmic microsurgical instruments - to train staff at eye clinics to maintain and repair these instruments.

Objectives

The objectives of this project were the following:

- Development of simple techniques to maintain and repair surgical instruments in different settings
- Assembly of a toolbox with all necessary tools, instruments and consumables to perform the maintenance and repair techniques
- Production of training and reference materials
- Train staff at eye clinics in the maintenance and repair of surgical instruments.

Methodology

Training

Training was designed for ophthalmic and technical staff in eye clinics in different hospital settings in several countries in Africa and Asia. It was decided to have training on site rather than in a central place in the country. This way more people from one clinic could be trained. In addition, this would provide the possibility of giving assistance in overcoming any initial or specific problems of a certain clinic. Further, more instruments would be available to give the staff trained more 'hands on' training in the techniques, using instruments from their own clinic.

Toolbox

A toolbox was assembled with all necessary tools to repair instruments and to manufacture some consumables. These tools included different sharpening stones, files, pliers, needle bending pliers, soldering equipment and lens cleaning cloths with enough consumables to last the clinic for at least one year. For sustainability reasons, the tools were good quality so they would not break down. Each clinic received a toolbox with the tools and instruments which are necessary to carry out the techniques on maintenance and repair of instruments.

Practising the techniques after instruction

Photo: Danny Haddad

ITIR, Manual and Video

Together with the Intermediate Technology Information Ring (ITIR), the manual on Appropriate Technology in Ophthalmology was revised in 1996. This manual was used as a reference manual for the clinics visited. A detailed video on maintenance and repair was produced for training purposes by the Jan Worst Research Group and the ITIR. With support of the Fred Hollows Foundation, a comprehensive manual to accompany the video was written as well. The video is available in English and French as VHS videotape and Video CD (mpeg) and the manuals in English as hardcopy or pdf file.

Training Materials

For further information about these training materials, contact Dr Danny Haddad by email to dhaddad@hetnet.nl

Editor

Clinics

In each country where the project took place an average of four clinics were visited. An introduction was given to the ophthalmologists of the clinics, with further in-depth training of theatre nurses and/or hospital technicians. During the project, 31 clinics in nine countries (Ghana, Zimbabwe, Malawi, Tanzania, Kenya, Uganda, Ethiopia, Papua New Guinea and Nigeria) were visited. The hospitals were a mixture of teaching, provincial and mission hospitals.

Workshops

Workshops were conducted in both Lao PDR and Vietnam, with participants from six and nine clinics respectively. Due to limited time the workshops in these countries were performed at a central place rather than visiting all the separate clinics.

Techniques Taught and Used

To understand what is wrong with an instrument, its way of functioning has to be understood. This included the testing of instruments to see if they were working properly or malfunctioning.

Cleaning instruments

The importance of good cleaning of instruments was stressed, especially in regard to rust prevention and sterility when using liquid sterilisation. Correct ways of cleaning were demonstrated, using mild soaps and gauze.

Maintenance of equipment and instruments

Maintenance of ophthalmoscopes and slit-lamps was included in the training sessions after clinics reported this to be a major problem. The most common problem was accumulation of dust on lenses.

Repair of surgical instruments

The most important technique was sharpening of scissors. A small and very fine sharpening stone was included in the toolbox to sharpen ophthalmic surgical scissors. Most of the clinics visited had a box with non-functioning scissors, which were mostly blunt. Other techniques included were repair of worn out needle holders and forceps.

Manufacturing of consumables

Depending on the needs of the clinic, manufacturing of consumables was taught. The consumables offered included 8–0 silk sutures, surgical knives (using non-breakable razor blades) and cryo-extractors.

Lessons Learned

Visiting separate clinics versus workshop in a central place

At the start of the project it was decided to visit the separate clinics instead of performing one workshop at a central location, although this had a major time implication. It was possible to set up the project in this way, since volunteers performed all the projects. With the experience in Lao PDR and Vietnam, both ways could be compared. In the authors' view the visit to clinics had better results because there was time to give the trainees enough 'hands on' training and enough instruments were available for practice under guidance. During the workshop approach there were too many participants to give appropriate supervision during the practical sessions. Further, most clinics visited had specific problems which we were able to address during the visit.

One of the technicians who was trained had already received training in repair of instruments abroad. This technician complained that upon return it was not as easy as was shown during the training session.

Using newly made instruments in the operating theatre
Photo: Danny Haddad

Training of hospital technicians versus training of theatre nurses

In clinics where technicians were available, both technicians and theatre nurses were trained. Some clinics, with rotation of the nurses between theatre, OPD and the wards, wanted to have all nurses included. For these groups more general sessions were held with in-depth training for a few nurses - to become the experts in the clinic. In some of the teaching hospitals it was found that the technicians were too busy with work in the other departments to find free time to assist in the eye department. The most successful was the training of technicians in specialised eye hospitals like the National Eye Centre in Kaduna and the ECWA Eye Hospital in Kano, both in Nigeria.

Training versus donation of tools with training guides

Several of the clinics visited had received sharpening devices. Most of these came with instruction manuals and/or videos. However, the techniques were still found to be complicated and not fully understood and the sharpening devices were not utilised.

Conclusion

In the opinion of the authors it is very important to provide training for technicians and/or nurses in the maintenance and repair of microsurgical instruments in theatre and OPD. All clinics visited had a large number of instruments which were either blunt or broken. During training it is important that the participants receive enough experience through practical training. Providing training in their own clinic gives the participants the possibility of performing repair on their own instruments and in their own setting. Donating repair sets without the appropriate training gives poor results, since most training manuals and videos are still too complex.

The importance of regular maintenance should be stressed as this will often prevent the development of defects in equipment or instruments. A record of maintenance and of items repaired should be kept. This is particularly appropriate for larger items of equipment and, for example, surgical cataract sets.

It will be helpful if each clinic has a person recognised as responsible for maintenance, who will also keep maintenance records and make sure that regular maintenance is carried out.

First published in *Community Eye Health* Vol. 15 No. 44 2002; pp. 60–1.

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Instrument repair for remote eye units

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Many skilled eye surgeons in remote hospitals face the frustration that a simple instrument, once in good working order, is now bent or broken. Many eye units have a box containing instruments needing repair, hidden away in a stock room cupboard, in the hope that someone, someday, will be able to redeem them.

This article gives guidelines on:

1 How to assess instruments and identify those that can be repaired locally, those that should be sent to a professional repair service and those that cannot be repaired at all.
2 How to make adjustments and carry out basic maintenance and repairs of surgical instruments.

The article will refer primarily to instruments in an extracapsular cataract extraction set.

Figure 1. Basic repair set (right)

1 light brass hammer
2 bending tool
3 cotton wool
4 600 grit diamond file
5 small Arkansas stone
6 assorted fine files
7 mild abrasive (tooth paste)

Assessment

Quality of the instrument

A good quality instrument is worth repairing. Many less expensive instruments have been poorly hardened and will wear quickly, bend or become dull. Considering the time and effort required, these might not be worth repairing.

Amount of damage

Cracks in the metal, flaking of metal fragments or sharp edges on 'blunt' instruments risk injury to the patient's eye during surgery. If these defects cannot be repaired adequately for patient safety, the instrument should be discarded. Cracks in the hinges of scissors, needle holders, forceps joints and haemostats will continue to cause problems with alignment and cannot be repaired. Sometimes such instruments can be used for spare parts.

Value of the instrument

If an instrument such as a capsulotomy scissors, one of the most expensive and most delicate of instruments, needs to be adjusted or sharpened, it is worth sending to a reputable repairer. These scissors are difficult to sharpen and the

Fig. 1. Basic repair set

Photo: Sam Powdrill

metal is extremely hard and brittle. Any attempt to bend the instrument can cause irreparable damage.

The following instruments can usually be repaired on site depending on the experience of the repair technician:

- A *dialler* or *muscle hook* is less expensive, it is made of softer metal and can be easily straightened
- A *Westcott's scissors* can usually be adjusted, tightened and sharpened but this needs some skilled attention
- Most micro forceps – *Colibri*, *Hoskins,* tying and toothed forceps – can be realigned. If the teeth are broken it can be repaired but it is difficult. It may be more feasible to remove the teeth and make a tying forceps out of the instrument instead
- With the correct tools, a groove can be re-cut in a grooved forceps.

Re-usable knives can be sharpened but it requires some skill to sharpen the point and keep the edge smooth. Preferably, this should be done by a professional repair service.

Remember!

- Careful handling while inspecting, adjusting and repairing instruments will avoid injury and reduce damage to the instrument
- Always clean and sterilise surgical instruments before attempting to repair them or before sending to any repair service
- Repair technicians should wear safety goggles to prevent eye injury from minute fragments of metal.

Maintenance

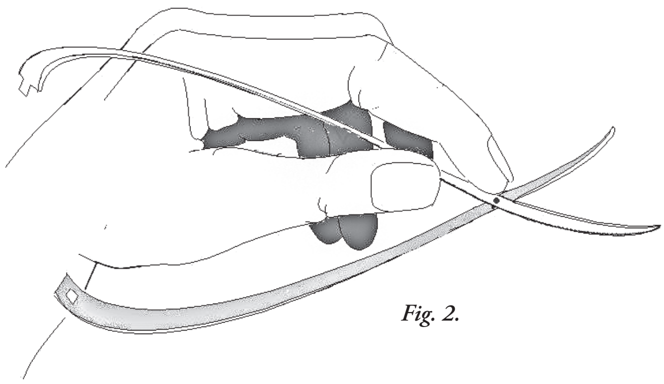

Fig. 2.

Inspection

First determine what the problem is. It is good practice to try to find only one cause to explain why the instrument is malfunctioning. The operating microscope, when not in use for surgery, can be used to inspect and adjust instruments.

Look for bent parts, loose or cracked hinges, scissors or haemostat jaws which do not meet properly or have excessive wear, broken teeth, grooves, rust pitting or shiny areas where there are rubbing points.

Listen for clicks in toothed forceps, scissors or hinges.

Feel for abrasion, roughness or friction.

Test for sharpness. Check surgical blades by piercing a piece of rubber glove stretched over a small container (e.g., a photographic film container). The blade should enter smoothly without a 'pop' or resistance.

Check scissors for sharpness with a few strands of cotton wool. The scissors should cut the strands cleanly without dragging.

While making repairs re-check the instrument periodically in the same manner.

Cleaning and lubricating the moving parts

Stainless steel instruments will also rust if left wet. This can be reduced by always using distilled or rain water in boilers and autoclaves. Instruments should be dried thoroughly before storing. An instrument may become rusty and the moving parts (e.g., the hinge) will stop working. Commercial rust removal and cleaning solutions are available but soaking in Coca-Cola for 30 minutes only is usually effective. Prolonged soaking will damage the instruments. Instruments should be rinsed in distilled water.

A scissors or needle holder with a corroded or stiff joint can be freed up by applying a mild abrasive compound (e.g., ordinary toothpaste), while moving the joint open and shut. Commercial grinding or rubbing compounds are available. A proper lubrication solution should be applied after thoroughly cleaning and drying the instrument.

A Simcoe irrigation/aspiration canula often gets blocked. The blockage is almost always at the tip where the small aspiration port opens. NEVER try to unblock the canula by heating it in a spirit lamp as this will melt the solder and cause a rough canula. Soak it in water first then use a small stainless steel wire alternately from each end of the canula to work the blockage free. This can be done under the microscope or slit lamp to increase visibility.

Adjustment and Repair

Alignment. Check teeth and jaws under the microscope. With a locally made bending tool, and a little practice, many instruments can be repaired easily (see Box 1, Figures 3 & 4). Find the point of greatest misalignment and straighten this first. When bending, choose a slot that fits the instrument well and over-correct slightly because the metal will spring back a little.

Box 1 How to make your own bending tool

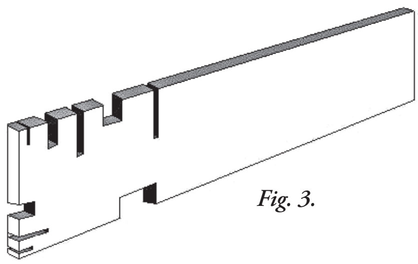

Fig. 3.

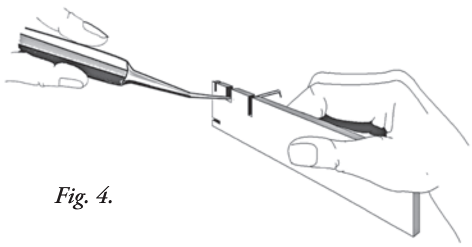

Fig. 4.

The suggested dimensions for a bending tool are one inch wide, five inches long and 1/8 to 1/4 inch thick. The bendingtool should be made from brass or mild steel (Figure 3). The grooves on the tool can vary in width from the thinnest cut that you can make up to about to 1/4 of an inch. Narrow slots are preferable. The slots can be cut with a hacksaw and smoothened or widened with a file (Figure 4).

Filing or grinding. Any filing or grinding to remove defects, reshape or restore an instrument should be done only as a last resort. It is important to maintain the original crafted design and shape of the instrument. Filing or grinding removes a lot of metal quickly and can permanently destroy it. Concentrate on removing metal from the flatter surfaces first, and then only small amounts from edges and corners.

Sharpening. Scissors and reusable knives require skilled attention. Practice first on old instruments as good instruments can easily be ruined in the hands of a novice.

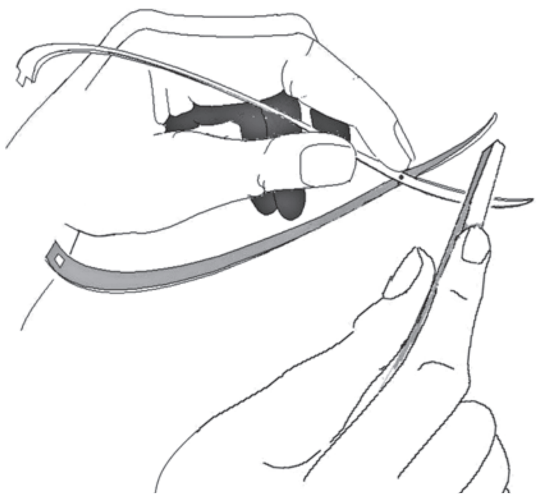

Fig. 5.

1 Hold the instrument firmly against a block or table edge
2 Always maintain the same sharpening angle with which the instrument was manufactured
3 Use a smooth, even movement at the same angle with every stroke of the stone (smooth Arkansas stone 800–1200 grit). A more expensive 600 grit diamond file is useful for coarse sharpening and shaping
4 Always sharpen in one direction into the cutting edge (Figure 5)
5 Hold the blade so that light reflects off the surface being cut and you can see that you are maintaining the same angle on every stroke
6 Never sharpen along the inside hollow surface of the blade as this has been hollow machine-ground by the manufacturer.

Note: If you do not have an Arkansas stone, a piece of 1,000 grit wet emery paper can be glued onto a small piece of wood (e.g. a tongue blade) and used instead.

Tightening. The hinge on a scissors, needle holder or haemostat may become loose. A good instrument probably has a screw in the hinge but many have a rivet.

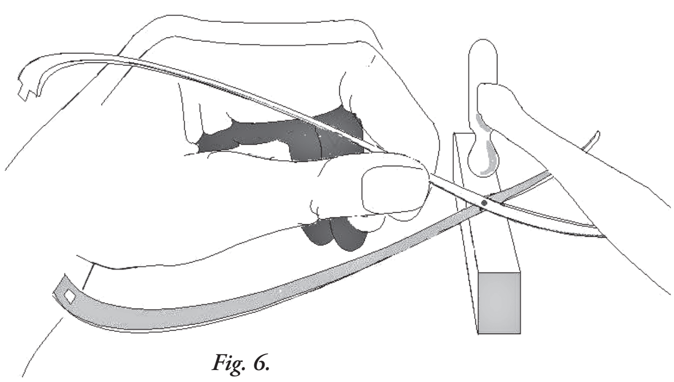

Fig. 6.

1 If the screw can be tightened, do this first. Often half of the head of the screw will break off. Then gently knock over the edges of the end of the screw to stop it loosening again.
2 If there is a rivet or a screw that will not loosen, tighten the joint by placing the joint flat on a metal surface and gently tapping with a very small hammer (Figure 6).

Finish. A smooth shiny finish (surface) resists rust. A smooth dull finish causes less distracting light reflection for the surgeon while operating.

Repair the finish by first using coarser abrasives and then finer and finer abrasives, ending with a polishing compound.

Final sharpening of scissors should be done after polishing is completed. Make sure instruments are thoroughly washed and cleared of all grit before being used again.

Wet emery paper in grit sizes 200, 400, 600,1,000 is recommended. Always use these with water, a little liquid soap may be added. Many excellent abrasive alternatives are now available from jewellers' supply companies but these are expensive.

First published in *Community Eye Health* Vol. 17 No. 51 2004; pp. 44–5.

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Mould in optical instruments

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Mould can damage optical instruments beyond repair within only a few weeks. There is a good deal of information available on the treatment of mould in buildings, because common respiratory problems and allergic reactions can be caused by mould. Knowledge is also available in the field of conservation of books and fine art because of the high cost of mould damage. However, very little information is available on mould in optical instruments and the management of mould is often ignored by equipment manufacturers and users.

Moulds are plant organisms which form cobweb-like branching arms, from which spores project into the air (see Glossary). Moulds are very common and very widely dispersed. There are 250,000 species of mould, many of which can damage optical instruments. Among the moulds commonly found in instruments are members of *aspergillus, penicillium* and *trichoderma* species.

Conditions of Growth

Although moulds grow in almost every environmental condition on the planet, most prefer temperatures of 20–30°C and relative humidity in excess of 90%. Moulds can germinate from nutrients stored in the spore, but, for growth, they need an additional source of nutrients such as protein, carbohydrate and cellulose. The mould network produces a microclimate close to the supporting surface which can trap dust particles containing nutrients, and can maintain the conditions of temperature and humidity needed for growth. In conditions of high humidity and moisture, many of the nutrients come directly from water vapour in the air.

According to the International Organisation for Standardisation,[1] moulds cannot grow on the glass optical surfaces of lenses, prisms, mirrors or filters without access to other sources of nutrient – such as textile fibres and dust, grease and fingerprints, or varnish. This usually comes from the edges of the optical surface, from contamination left in the joint between the lens and the mounting cell during cleaning, or from varnish or other material in the mounting cell. Figure 1 shows the typical cobweb growth of a mould mycelium from the edge to the centre of a glass surface.

Mould can grow very quickly. It takes only a few days for mould spores to germinate, and only a few weeks to extend hyphae and grow extensively. Many regions of Africa, South-East Asia and Latin America provide ideal conditions of temperature and humidity for rapid mould growth. Even so, within these regions, the individual risk of damage to instruments varies widely. Some optical instruments are kept in operating rooms, clinics or laboratories which are continually air conditioned and so the humidity never reaches the level needed for mould growth, while others are not. Some instruments have internal fungicidal protection, while others do not. Each instrument must be individually assessed for risk, based on its environment and on the importance of mould damage to it.

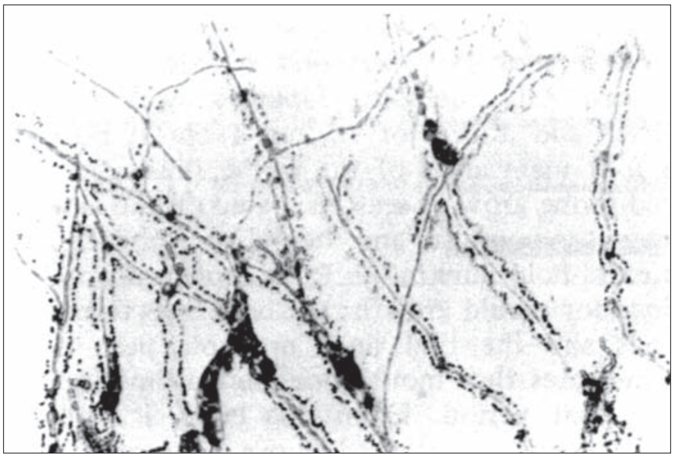

Fig. 1: Typical mould network extending from the edge to the centre of a glass surface (from Kaneko[2])

In countries where the conditions for mould growth are optimum, mould is often seen on the outside surfaces of optical instruments such as the eyepiece and objective lens surfaces. Mould on internal surfaces may be seen through the instrument if it is close to a focal plane, but usually it is only evident by reduced light transmission or reduced image quality caused by scattering or absorption of light in the mould mycelia. If there is a rapid loss of light transmission or image quality, the possibility of mould should always be considered.

Mould can also damage instrument electronics through short circuits and corrosion, but this can usually be repaired. Damage to optical surfaces is rarely cost effective to repair. A growing mould mycelium produces organic acids which etch the glass surface with minute grooves, leaving behind a print of the mould network (Figure 2) and, as optical components cannot be resurfaced economically, the instrument is then destroyed.

Some glass types are attacked by mould much more readily than others.

Anti-reflection coatings seem to have little effect on the susceptibility of glass surfaces to mould attack, and these coatings are etched along with the glass substrate.

Inhibition of Mould Growth

Two methods are commonly used to inhibit mould growth in instruments.

1. **Environmental control**. Some military optical systems are filled with a dry gas and then sealed, but this method is not used in commercial instruments. Storing the instrument at a relative humidity of less than 65% will prevent

the growth of most moulds. This can be achieved either by storing in an air conditioned room, or in a sealed container (a sealed plastic bag may be enough) with a drying agent. If a drying agent is used, it is essential to use one which changes colour when it is saturated and dry or replace it when this becomes necessary.

2. **Fungicides**. Fungicides have been added to instrument varnishes, waxes and cements, to surface coatings of lenses, and to replaceable strips and pellets. The fungicide must provide a concentration throughout the instrument sufficient to prevent mould growth, but, at the same time, not sufficient to condense on optical surfaces or corrode components. In Australia, defence optical instruments have had the fungicide, ethyl mercury thiosalicylate incorporated into paints, cements and waxes to inhibit mould growth. Some optical instruments have also used radioactive or fungicidal surface coatings on optical components, but this is not common and, according to the International Organisation for Standardisation,[1] is not effective. The useful life of a fungicide is necessarily limited by evaporation of the active ingredients unless the instrument is completely sealed, and so attempts to incorporate a permanent fungicide have largely been replaced by the use of replaceable fungicidal pellets. These can be obtained from many instrument manufacturers, and have a useful life of about three years.

Cleaning Mould Contamination

Moulds do not have roots attached to the optical surfaces, and so can be wiped away easily. A mixture of alcohol and ether is often used to clean optical surfaces. Care must be taken in choosing the cleaning agent, as many solvents such as acetone may damage antireflection coatings, paint work and plastics.

Ordinary facial tissues should not be used to clean optics. The paper often contains grit particles that scratch, and lint that is electrostatically charged and is hard to remove. A commercial lens cloth, or a cotton cloth that has been washed several times, should be used. Cotton buds are suitable and can reach some of the internal optical surfaces that are difficult to clean.

It is hard to remove mould spores completely once they have become established, and optical instruments that have been affected by mould should be cleaned regularly to prevent regrowth.

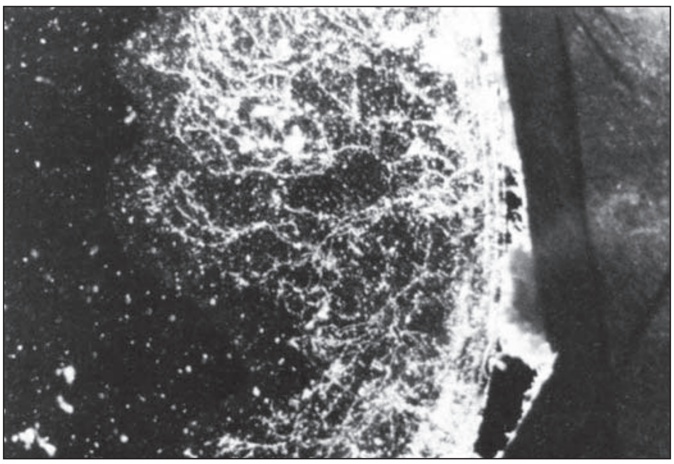

Fig. 2: Grooves etched into a glass surface by organic acids from a mould mycelium (from Kaneko[2])

Rules for Managing Mould in Optical Instruments:

1. Do not wait until mould appears on the outside surfaces of an instrument. By then it may be too late.
2. Inhibit mould growth, if possible by installing a fungicide in the instrument and changing it at recommended intervals, and by storing the instrument in a relative humidity of less than 65%.
3. Inspect the instrument regularly, and clean the accessible surfaces with a disinfectant.

GLOSSARY	
Fungus:	A sub-division of the *Thallophyta* division of the plant kingdom. Fungi are simply organised plants, either single celled or made of cellular filaments, and lacking in green colouring matter (chlorophyll).
Fungicide:	Any substance which destroys fungus.
Germination:	The sprouting or budding of a mould; production of the initial shoot of a hypha.
Hypha:	A filament of a fungus, composed of one or more cylindrical cells. Hyphae increase in length by growth at the tips and give rise to new hyphae by lateral branching.
Mould:	Any superficial growth of a fungus mycelium.
Mycelium:	The collective term for the mass of hyphae that constitutes the growing part of a fungus.
Nutrient:	Any substance that provides nourishment to the mould.
Spore:	Single – or multi-celled reproductive body that becomes detached from the mould and gives rise to a new individual. Spores are usually microscopic, and are produced in a variety of ways. They are often produced in enormous numbers and are distributed widely, serving for a very rapid increase in the population of the mould. Spores may be able to survive over long periods that are unfavourable to growth.

References

1 International Organisation for Standardisation. *Optics and optical instruments-Environmental test methods – Part 11: Mould Growth*. ISO 9022–11:1994.

2 Kaneko N. Optical instruments and mould. Nikon Kogaku KK Bulletin MCCD-01 TEM 603–10/1.

First published in *Community Eye Health* Vol. 16 No. 46 2003; pp. 28–9.

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Care of ophthalmic surgical instruments

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This article gives an overview of the principles of surgical instrument care. Both subjects are covered more comprehensively in *OPHTHALMIC OPERATING THEATRE PRACTICE: A Manual for Developing Countries.* (See Useful Resources)

HANDLING OF OPHTHALMIC INSTRUMENTS

All ophthalmic instruments need exceptionally careful handling.

- Scissor points are extremely delicate; the tips should not be touched
- All scissors, needle holders and fine forceps need to have their tips protected. The protectors must cover the whole blade or jaws of the instrument
- Scalpel blades and knives must be passed to the surgeon by the handle with the cutting edge pointing downwards. Artery forceps must be used to remove the blade
- No instrument should ever be thrown down! Eye instruments are extremely delicate.

Caution is needed when disposing of needles and other sharp instruments ('sharps')

- Needles must be disposed of in the correct receptacle. During the operation, all sharps are kept in a gallipot on the instrument trolley and later disposed of safely; an old infusion bottle or any tough plastic receptacle can be used as a 'sharps' container. When the receptacle becomes two-thirds full it should be sealed with tape and incinerated
- Needle stick injuries are frequently caused by re-sheathing disposable needles. This is NOT recommended! These needles should be disposed of immediately after use in the receptacle provided
- Needle stick injuries must be reported immediately to the person in charge. There should be a hospital policy regarding needle stick injuries and this must be followed
- The chances of transmitting the AIDS virus with a needle prick are thought to be 1 in 1000, or higher, in some countries
- Never re-sterilize disposable needles.

Ophthalmic instruments need particularly careful handling
Photo: Kikuyu Eye Unit

MAINTENANCE

Cleaning

Rain water or distilled water is preferred. If neither is available, freshly boiled tap water may be used.
The following method should be used after each operation.
Three containers are required:

Container 1 : hot soapy water

- The instrument must be supported carefully whilst cleaning
- A soft toothbrush can be used to clean each instrument individually
- Needle holders, scissors and artery forceps must be completely opened to clean inside the jaws
- Cannulae must be flushed through. Lens matter, vitreous and visco-elastic gel block cannulae permanently
- Cotton wool should not be used to clean instruments as it damages the tips.

Container 2 : lubricant

- A lubricant prevents the development of stiff joints and inhibits the development of corrosion
- Lubricant is needed for hinged instruments only, e.g., scissors, needle holders and artery forceps
- The instruments are dipped, one by one, into the lubricant; they must NOT be soaked
- If a lubricant is not available, the instruments should be rinsed in clean hot water
- Do NOT put cannulae in lubricant.

Container 3 : clean hot water

- Excess lubricant or soap is rinsed off and the instrument left in the open, dismantled position on a clean absorbent cloth
- Cannulae must be flushed through again to remove any soap debris.

Drying

- Instruments must be dried thoroughly before being stored. If the instruments are put away wet or damp they will rust
- A hair dryer is very effective for drying the joints and crevices of instruments. If a hair dryer is not available, dry gauze may be used cautiously
- Never force open a forceps even when drying, as this will distort the instrument.

Inspection

Before storing, all instruments should be carefully inspected, as follows:

- Hinged instruments should be checked for jaw alignment
- Micro-scissors should be able to cut through one thickness of surgical glove. The tips should be smooth and in alignment
- Dissecting forceps should meet at the tips and be aligned
- Grooved forceps, when held up to the light, should show a perfect circle at the tips. The forceps should be symmetrical
- Needle holder tips must meet allowing for the suture to be held well. There should be no gap between the jaws. The needle holder should open and close smoothly
- Blades should retain a sharp, smooth edge
- Cannulae should be flushed with air to ensure patency and dryness.

Corrosion and rust

Corrosion and rust is caused by:

- Inadequate cleaning, rinsing and drying

Needle holder tips must meet, allowing the suture to be held securely
Photo: Mark Reacher

All instruments should be carefully inspected before storing
Photo: Kikuyu Eye Unit

- Using tap water
- A malfunctioning autoclave.

Most instruments are made from stainless steel. Stainless steel does not usually rust. However, it can corrode if it is washed in saline or left to soak for a long period of time in any liquid.

Once the instrument has started to rust it will become weak, and the rust will eventually destroy and break the instrument (metal fatigue).

Rust commonly occurs on chrome or nickel-plated instruments. When the plating wears off, the carbon steel is exposed and is further corroded by autoclaving and washing. If this occurs the instruments cannot be sterilized properly.

Inexpensive instruments tend to rust more easily as the stainless steel is of a poorer quality.

Sodium nitrate is an anti-rusting agent and can be used in conjunction with the lubricant or on its own. Two tablets can be dissolved in 500ml of water, when washing the instruments.

Instrument stains

Thorough inspection may reveal discolouration of the metal. Some stains can be rubbed off with a rubber eraser but it may leave a rough surface. Contact with hydrochloric acid and iodine should be avoided.

Instruments not rinsed thoroughly after chemical sterilization will stain. Manufacturer's recommended soaking times must not be exceeded.

Oiling

With repeated sterilization, instruments will become stiff and difficult to open. A good quality sewing machine oil or silicone oil should be used each week on hinged instruments. This is especially relevant when working in a very hot, dry climate.

- Use a 2ml syringe and 21G needle to draw up the oil
- Change to a 25G needle, open the instrument and place a drop in the jaws; work in the oil by repeatedly opening and closing the instrument
- Wipe off any surplus oil with gauze.

Surplus oil on an instrument will inhibit sterilization. Using an instrument lubricant will help to maintain the action of the instrument but oiling is still necessary.

Repairs

Eventually scissors will need sharpening, forceps re-aligning, etc. Instrument companies will repair and re-sharpen instruments to a high standard but repairing instruments takes time. The cost of a good repair is much cheaper than buying a new instrument.

STORAGE AND TRANSPORTATION

Shelving

Glass shelving is preferred, as it is easy to keep clean. Ideally, instruments need to be in a dry, well ventilated, secured cupboard. A drying agent, e.g., silicone gel can be placed on the shelves to absorb moisture in the air.

- The instruments must be arranged in an orderly manner and labelled
- Protectors should be used when instruments are in storage
- Never pile instruments on top of each other!
- Micro-scissors work on a spring action and are kept in the open position until in use
- Needles and cannulae can be sterilized ready for use on a silicone mat or a thick piece of material.

Instrument Trays

Individual slots in the tray hold one instrument; this prevents the instruments touching. Trays are useful for transporting instruments, e.g., to outreach clinics and the sets are ready immediately for sterilization. Protectors must be used.

Instrument Rolls

This is a length of material with pockets to hold an individual instrument. The roll is tied with a piece of string to keep it secure. Instrument rolls are cheap, easy to make and are excellent for transportation purposes. Protectors must be used.

Instrument Cases

These cases are metal or plastic boxes containing a protective silicone mat which prevents the instruments touching during storage and sterilization.

SECURITY

Ophthalmic instruments are very expensive and delicate. It is therefore necessary to ensure a secure place to store the instruments when not in use.

- Storage shelves should be in a locked cupboard
- New members of theatre staff should be instructed carefully in the care and maintenance of theatre instruments
- A person of integrity should be made responsible for the care of instruments
- An inventory of all instruments should be carried out monthly to ensure that there are no discrepancies
- Any instrument that is faulty must be removed immediately from the theatre and sent for repair
- The operating theatre should be locked and windows shut when not in use.

First published in *Community Eye Health* Vol. 13 No. 35 2000; pp. 40–1.

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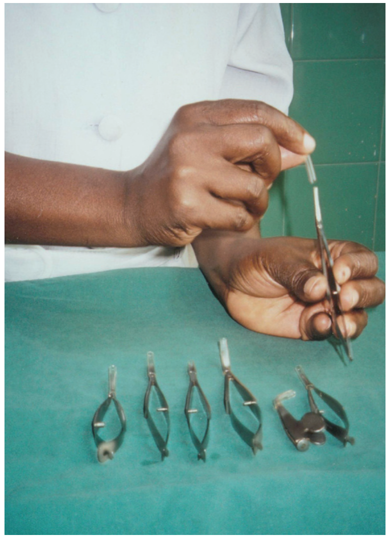
CARE OF OPHTHALMIC SURGICAL INSTRUMENTS

Handling and Safety

Sharps

Protect the tips of all sharp instruments with silicone or rubber tubing.

Intravenous infusion tubing or tubing from 'butterfly' intravenous needles may be used.



Remember!

Never re-sheath a disposable needle

Always use artery forceps to remove a blade from a Bard Parker handle

Provide a gallipot on the theatre trolley to collect used needles and blades

Do not touch the tips of any instrument

Never throw an instrument

Needles

Discard used needles immediately after use.

Place in a receptacle used only for this purpose.

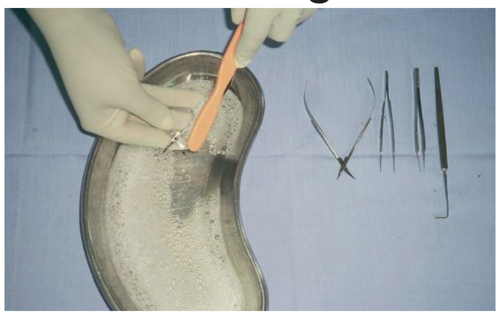
Do not over-fill.

Preferably use small receptacles and dispose of them daily.

Seal and incinerate the receptacle when almost full.

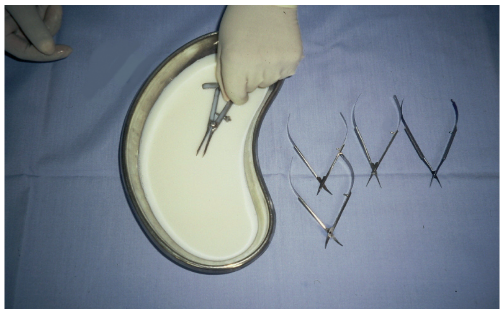
Maintenance

Cleaning



Use a soft toothbrush and hot soapy water to clean thoroughly each instrument individually and ***in its open position***.

Lubricating

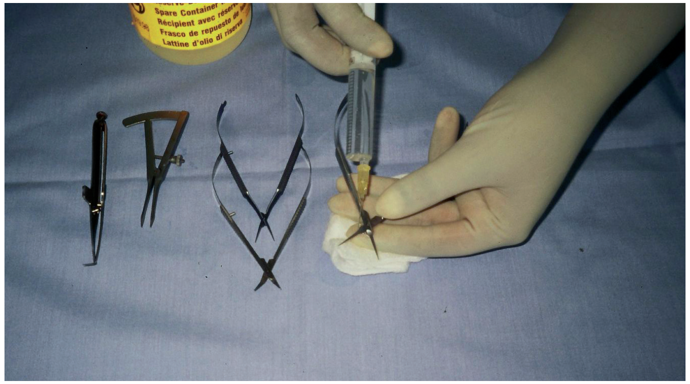


Use a lubricant immediately after cleaning hinged instruments to prevent stiff joints and to inhibit rusting. Dip the instruments only and then rinse, but ***do not leave to soak***. Down's Surgical Instrument Lube or Dixey's Surgi-Slip are recommended.

Drying

Instruments must be dried thoroughly before storing.
Dry gauze (used cautiously) or a hairdryer may be used.

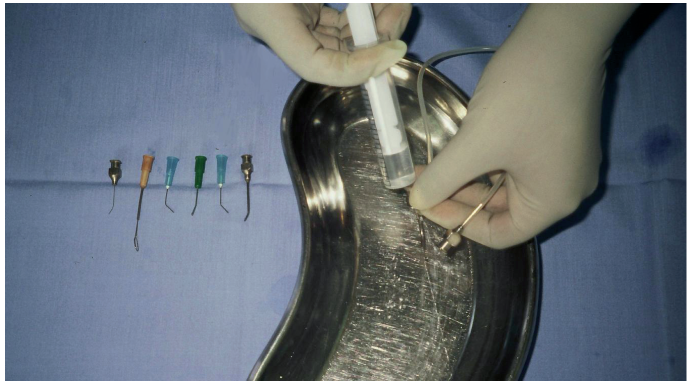
Oiling



Stored hinged instruments need oiling weekly. Use a 2 ml syringe and 21 gauge needle to draw up the oil, and a 25 gauge needle to apply oil to the joints. Surplus oil should be wiped off carefully with gauze. Ordinary sewing machine oil is recommended.

Inspect instruments for alignment and sharpness under a good light and magnification.

Inspection



Check that the lumen is patent (not blocked) by flushing through with clean hot water.

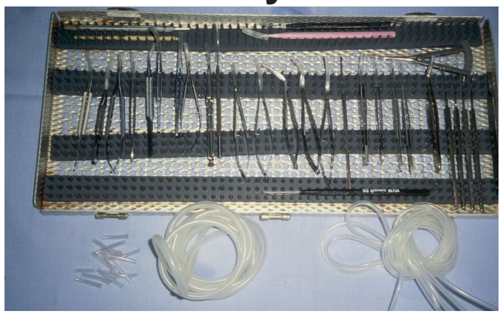
Storage, Transportation and Security

Silicone or rubber protectors must be used on sharp instruments when in storage or transit

Shelves

Glass shelves in a lockable cupboard provide for secure storage and checking.
Never pile instruments on top of each other.
A well ventilated room is recommended.

Trays



Each individual slot in the tray holds a single instrument.
Instruments must not touch each other.
The tray can be used for storage, transportation, and during some sterilization procedures.

Cases

Cases may be of metal or plastic and contain a protective silicone mat.
The case can be used for storage, transportation, and during some sterilization procedures.

Rolls

Rolls, made of strong fabric, are inexpensive.
Each pocket holds a single instrument.
Secure the roll with ribbon or cord, ***not elastic***.
Use rolls ***only for storage and transportation*** of instruments.

INTERNATIONAL CENTRE FOR EYE HEALTH

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This poster highlights the main principles discussed in a full article in *Community Eye Health Journal*, Vol 13, Issue Nº 35, 40-41, 2000.
Supported by **Sight Savers International, Christian Blind Mission International**, and **Dark & Light Blind Care**.
Photos: Ingrid and Maxine Cox

Transmission and control of infection in ophthalmic practice

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Introduction

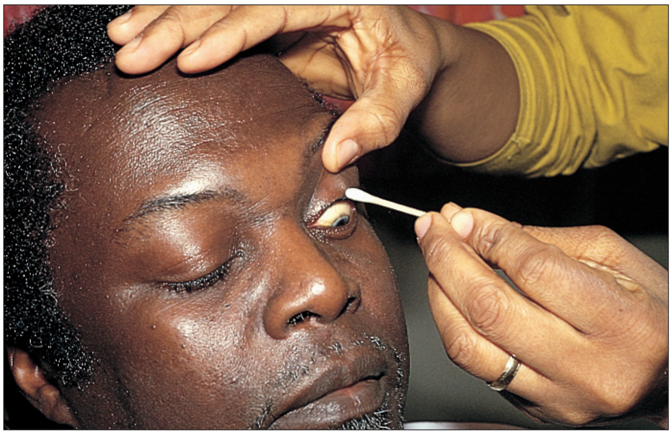
Eye infection may be bacterial, viral, chlamydial, fungal or acanthamoebic, and these infections account for a large proportion of the workload in ophthalmic centres.[1] Cross-infection may occur through contaminated instruments, hands, communal towels and droplets. Patients with dry eye or inadequate lid closure are more susceptible. Other risk factors are low immunity, malnutrition, general disease, contact lens wear and extremes of age.[2]

An overview of some common eye infections, causative pathogens and spread mode is given. This is followed by an outline of general infection control principles, with additional specific considerations for ophthalmic practice.

Common Eye Infections and Spread Mode

Conjunctivitis may be bacterial, viral or chlamydial and is a common cause of unilateral or bilateral infected red eyes.

- Bacterial conjunctivitis, usually caused by *Staphyloccoccus aureus,* is more common in children. The signs and symptoms are sticky, purulent discharge, foreign body sensation, with peripheral conjunctival redness. The pupils are normal and the cornea is clear. The visual acuity is usually unaffected, unless there is corneal complication. Bilateral purulent discharge in the newborn requires urgent referral, as this may indicate infection with *Neisseria gonorrhoeae* or possibly *Chlamydia.* The patient and parental sexual partners must be examined and treated by a specialist health care worker as soon as possible. *Neisseria gonorrhoeae* infection may result in loss of sight, if treatment is delayed.
- Viral conjunctivitis is bilateral and more contagious, with redness developing acutely in one eye first, followed some days later in the second eye. Adenovirus types 8 and 19 can cause kerato-conjunctivitis and subsequent blurring of vision. Other strains may be associated with upper respiratory tract infection. Signs include serous discharge, tarsal follicles, swollen lids and tender pre-auricular nodes. Patients should not attend work or school until infection has cleared, over 1–3 weeks.[3]



Lid scrubs are essential for blepharitis management

Photo: Pak Sang Lee

Other viral infections include herpes simplex, varicella zoster and molluscum contagiosum.

Herpes simplex conjunctivitis may be present together with a dendritic corneal ulcer. Varicella zoster conjunctivitis occurs secondarily to ophthalmic shingles. Molluscum contagiosum is commonly associated with a mild, but chronic, follicular conjunctivitis and superficial keratitis, which does not respond to antibiotics. Measles and mumps are also causes of conjunctivitis.

Blepharitis (inflammation of the eyelids) tends to run a chronic course and may occur together with conjunctivitis, because the structures involved are anatomically joined.

Staphylococci and *Propionibacteria* are common pathogens. In the USA, *Staphylococcus epidermidis* is more commonly isolated in patients with blepharitis (95.8%) than S*taphylococcus aureus* (10.5%).[4] Signs and symptoms are red, crusty lid margins, mild lid swelling, itchiness, dry sensation and occasional lacrimation. Vision is normal, unless the cornea becomes involved. The condition commonly occurs in unhealthy environments or in those with skin problems. Daily lid 'scrubs' and a healthy diet are essential in managing this chronic disorder. A course of antibiotic eye ointment may be prescribed.

Contact lenses have become increasingly popular for reasons of convenience, efficiency in improving vision in certain sports and occupations, and also for their cosmetic advantage. A host of pathogens have been found in ocular tissues, storage contact lens cases and solutions. Studies reveal that in over 50% of asymptomatic contact lens wearers, lens cases are contaminated and these may contain *Pseudomonas aeruginosa* and other gram-negative bacilli. These readily adhere to the plastic surface of cases. These pathogens produce slime which enable them to survive disinfecting solutions. Rakow (2000) reported that non compliance with an effective hygiene regime can lead to corneal infection and sight loss.[5]

Home made saline and tap water are known to harbour

Box 1: Instructions for Patients with Eye Infection

Remember: Eye infection is easily passed to others. Flies will be attracted to sticky eyes

DO!	DO NOT!
• wash hands before and after instilling eye medication	• do not touch or rub the eyes
• use only the drops or ointment prescribed	• do not touch the lids or lashes with the dropper or applicator
• wash the face frequently, especially before instilling medication	• do not share face cloths or towels
• wear sunglasses, if available, to provide comfort	• do not wipe the face with clothing
• eat a healthy diet to aid recovery	• do not cover the eye with a dressing
• return to the health centre if the eye does not improve	• do not go to work or school until the infection clears
• destroy medication when the infection clears	• do not store medication in direct sunlight or within reach of children
	• do not share medication with others

Acanthamoeba species and individuals who use these are at risk of developing sight threatening corneal infection. Education of the contact lens wearer is the key to preventing complications.

Infection may have a profound effect on the patient's general health as well as damaging sight. The health care worker must be aware of the sequence of events in the transmission of infection. Figure 1 shows a possible chain of infection leading to acute conjunctivitis.

Table 1 shows how some viruses can be transmitted in a health care environment (see also reference below to adenoviral infection in ophthalmic practice).

In addition, patients with an eye infection need to be given clear instructions as well as appropriate medication to encourage recovery. This may be supported with a written advice sheet. Box No. 1 gives the necessary information. This could be reproduced as an individual handout, or for notice board display in the clinic.

General Principles of Infection Control

In many western hospitals, in recent years, the appointment of a Control of Infection Officer (usually a nurse) has become commonplace. This highlights the significance and challenge of infection control within clinical areas. Indeed a considerable number of infections are actually acquired within a hospital setting.

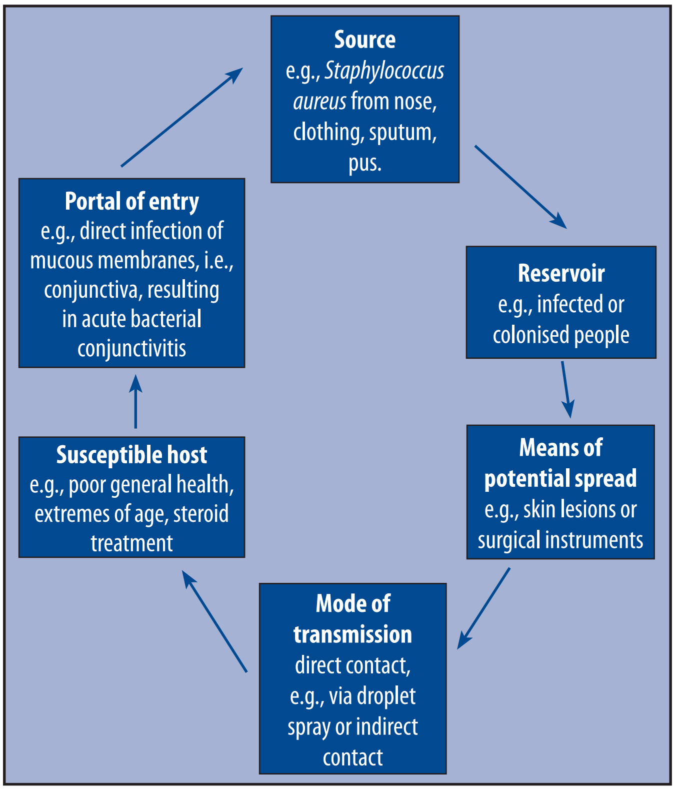


Fig. 1: Possible Chain of Eye Infection

• Personal hygiene and clothing

All healthcare workers of all disciplines have responsibility for infection control and this begins with their own personal hygiene. Individuals with any infection should not have direct patient contact. Any infected, or potentially infected, lesion must be covered with an occlusive dressing and reported to the person-in-charge who will decide if the staff member should take sickness leave until the infection has cleared.

Clothing should be changed daily. Studies have shown that hospital uniforms, over the course of a day, become a source of bacterial infection.

Jewellery, including wristwatches, should not be worn and fingernails should be kept clean and cut short. Clothing worn in the operating theatre must not be worn in other areas. Hair must be kept clean and covered. Beards are a source of infection. Facemasks must be worn properly to cover the nose, mouth and chin completely, changed for each operation and disposed of carefully. Cotton masks must be washed before re-using.

• Handwashing

Hands are the most important 'instruments' of healthcare workers and also the principal source of cross-infection in a healthcare setting.

Handwashing is the ***most important*** of all infection control

Table 1: Viruses that can be Transmitted in a Healthcare Environment

Virus	Transmission
Varicella zoster	Direct personal contact Droplet Airborne
Herpes simplex type 1	Direct contact with carrier saliva
Cytomegalovirus	Excreted in saliva and urine Transmitted by close contact, droplet spray and kissing
HIV	Body fluids: • blood • semen • breast milk • vaginal secretions • synovial fluid • cerebrospinal fluid
Rubella	Direct or indirect personal contact Droplet Crosses the placental barrier infecting and damaging a growing foetus

procedures, yet it is usually performed inadequately. Both technique and frequency are important – see Boxes 1, 2 and 3.

- **Gloves**

The proper use of gloves prevents cross-infection between patient and healthcare worker and vice versa. Despite the risk to self, a study in Nigeria showed that the main reason for non-compliance in wearing of gloves by healthcare workers with direct patient contact was because the practice was considered unnecessary.[6]

Gloves should be worn on both hands whenever there is potential contact with blood and other body fluids. The wearing of gloves is recommended for all eye surgery. For many years it was accepted that some ophthalmic surgeons chose not to wear gloves because of reduction in touch sensitivity, but this practice is no longer an option because of the risk of HIV and hepatitis B infection. A new, sterile pair of gloves should be worn for each patient contact.

Good quality gloves may be re-sterilised, but should be checked for damage – e.g., by filling with water, turning inside out and allowing to dry before re-sterilising.

An adequate supply of gloves should always be available.

Allergy and sensitivity to the latex material is currently being widely discussed.

- **Waste, spillages, linen and sharps disposal**

All clinical waste must be disposed of carefully. Soiled dressings and surgical remnants must be burned immediately. Soiled linen must be removed immediately and washed separately from routine changes of bedding, etc.

Disposable needles must be disposed of immediately after use, and separately in a closed impenetrable container, appropriately labelled. This may be burned or buried, preferably daily. Therefore, a small container is better than a large one.

If an accident occurs, i.e., a prick with a used needle or instrument, the wound should be allowed to bleed freely for a few minutes, then washed with soap under running water and covered with a sterile dressing. The HIV and hepatitis status of the patient, on whom the needle was used, should be noted. The incident must be reported to the person-in-charge and the injured worker examined by a medical practitioner.

Needles should not be used more than once, but if this is

The correct wearing of caps, masks and gloves is important for control of infection

Photo: Murray McGavin

not possible it is essential that proper sterilisation procedures are followed. Needles, used for the removal of corneal foreign bodies, etc., must not be left on the slit-lamp table top!

Spillages of body fluids must be wiped with disposable paper tissue or cloth, which must then be burned, and the surface cleaned immediately with detergent and water. Heavy-duty gloves should be worn when disposing of any waste material and cleaning after spillages.

- **Environment and equipment**

Patients expect, and have a right, to be cared for in a clean, safe environment. All health care workers have a responsibility to provide this. Basic cleaning of the hospital environment is a cost-effective method of infection control and must always be a pre-requisite for any subsequent disinfection and sterilising procedures. The areas/items requiring regular attention are walls and ceilings (often forgotten or ignored), floors, tables, stools and chairs, shelving and work surfaces.

Disposable healthcare materials appeared on the western market almost 40 years ago with the promise of raising standards, labour-saving and guarantee of reduction of infection rates. Some economic climates, however, have encouraged the practice of the re-use of disposable items to save money. Recycling must be carefully considered and monitored closely to ensure safety is not threatened.

Where the patient's meals are provided by relatives, care must be taken because contaminated food can contribute to hospital-acquired infection.

Box 2: Handwashing Technique

- Wet hands with clean, preferably running water
- Apply soap or cleanser
- Rub palm to palm
- Rub right palm over back of left hand
- Rub left palm over back of right hand
- Rub palm to palm with fingers interlaced
- Rub backs of fingers on opposing palms with fingers interlocked
- Rub around right thumb with left palm
- Rub around left thumb with right palm
- Rub around fingers of right hand with palm of left hand
- Rub around fingers of left hand with palm of right hand
- Rinse off soap thoroughly with clean, preferably running water, before drying well

N.B. Disposable paper towels are ideal but if a communal towel only is available for drying hands a clean one must be provided daily.
Hot-air hand dryers are not recommended!!
This is known as ***social handwashing*** and will take no longer than 30 seconds and is required before and after routine procedures in clinical areas.

Hand hygiene/disinfection, using the same technique, is achieved by using an antiseptic for 15–30 seconds and is necessary in the event of known infection, before aseptic procedures, and following contact with blood and body fluids.

Surgical hand-scrubbing includes washing the hands and forearms and nail brushing, requiring a minimum of 5 minutes *scrubbing* and a defined technique to remove micro-organisms before participating in invasive surgical procedures. It is an acquired skill needing supervised practice.

Box 3: Handwashing is Required in the Following Situations

- Before any aseptic procedure
- Before and after handling any patient
- After handling any soiled item
- Before and after handling food
- Whenever hands are, or even feel, soiled
- When entering or leaving a clinical area
- After using the toilet

Specific Considerations For Ophthalmic Practice

A separate unit for eye patients is ideal, but where this is not possible, care must be taken that patients with open infected wounds, ulcers or bed-sores are not accommodated in the same area as eye patients. Patients with eye infections should be separated from other ophthalmic patients in the ward, especially those who have had eye surgery. If surgery is performed on an infected eye, the operation must be scheduled last on the operating list and the theatre cleaned thoroughly afterwards.

- **Hands of the examiner and patient**

Eye infection can be spread by healthcare workers through simple social greeting of patients, i.e., shaking of hands. Patients often rub their eyes and contaminated hands will transfer the organism to the healthcare worker. It is important that hands are washed immediately before performing an eye examination and after the patient has left, before greeting another patient.

- **Slit-lamp biomicroscope**

The areas which come into contact with the patient must be washed with soap solution between patient examinations – chin rest, head rim, not forgetting the hand grips!

- **Tonometer prisms**

These should be wiped after use on disposable paper tissue and then placed (tip only) in a small pot of sodium hypochlorite 1% for at least 10 minutes between patients.
(NOTE: The prism must be rinsed in sterile water and dried before use!!) If there is suspected adenoviral infection the soaking must be extended to 30 minutes before re-using the same tonometer prism. A fresh sterile pot and new solution of sodium hypochlorite must be provided for every clinic session.

- **Occluder/pinhole**

This should be stored in a container of sodium hypochlorite 1% for at least 10 minutes between patients and wiped dry before use. There is no need to rinse. A fresh solution must be provided before each clinic session.

NOTE: Sodium hypochlorite causes corrosion – do not use stainless steel containers for the above.

- **Eye drops**

Ideally, each patient should have their own bottle of drops and, where there is known infection, separate bottles for each eye! However, in many situations this may be economically impossible. Care should therefore be taken to avoid eyedropper contact with eyelids, lashes, eyebrows and facial skin. Where possible a single-use dispenser should be used in out-patient examinations. Expiry dates must be checked, as out of date drops can be a source of infection.

Good personal hygiene and clean uniforms are important for prevention of infection

Photo: Sue Stevens

Expiry dates on drop bottles must be checked

Photo: Pak Sang Lee

- **Pathological specimens**

Scrapings of the cornea and conjunctiva may be taken using a disposable sterile surgical needle or blade. If a spatula or loop is used it must be sterilised before and after each procedure by flaming, and allowed to cool. Alternatively, it may be sterilised by chemical soaking.[5]

- **Eye dressings**

An infected eye must never be covered with a pad and/or bandage. Used eye dressings must be disposed of immediately and burned. Eye shields must be washed before being reapplied and, in known infected cases, must not be used on other patients. Cotton wool, gauze swabs or tissues used when instilling drops or ointment must be disposed of immediately.

- **Spectacles**

Wearers should be encouraged to wash their spectacles daily.

Policy

Eye infection can happen anywhere as eyes are particularly susceptible to Gram-negative bacilli, adenoviruses, herpes simplex virus and fungi.

Cross-infection is a costly and continuing concern. Multi-resistant *Staphylococcus aureus* (MRSA) has made alarming news worldwide as treatment is very difficult. Lives, as well as sight, have tragically been lost.

Health workers must aim to limit hospital-acquired infection. Lack of motivation and poor micro-biological knowledge will result in non-compliance. Eye units are advised to develop and teach an appropriate infection control policy with regular reinforcement and review.

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First published in *Community Eye Health* Vol. 12 No. 30 1999; pp. 25–8.

CONTROL OF INFECTION IN OPHTHALMIC PRACTICE

Risk Reduction Principles

PEOPLE

Consider all patients and staff as a potential infection risk.

Staff and patients should wash hands with soap before commencing any examination.

Wash hands with soap before and after every clinical procedure, even if gloves are worn.

Staff and patients with any broken skin, however small, must wear an occlusive dressing.

Staff with any known or suspected infection should not have direct patient contact.

SURGICAL INSTRUMENTS AND DECONTAMINATION PROCEDURES

Loaded needle holders: lay point down on trolley and table tops.

Pass sharp instruments to colleagues with verbal warning and eye contact communication.

Sharp instruments should not project beyond the surface edge.

Ensure surgical instruments are thoroughly cleaned before being passed for sterilization or disinfection.

Choose the appropriate sterilization or disinfection method for the specific instrument.

Emphasise care of instruments and steriilization and disinfection procedures in training programmes.

Critically review work practices regularly.

Include control of infection policies in training programmes.

Implement and emphasise strict adherence to universal control of infection policies.

Teach correct hand-washing technique and display a written procedure in all relevant areas (see above right).

HAND WASHING TECHNIQUE

Wet hands with clean, preferably running, water.

Apply soap or cleanser.

Rub palm to palm.

Rub back of left hand over right palm.

Rub back of right hand over left palm

Rub palm to palm with fingers interlaced.

Rub backs of fingers on opposing palms with fingers interlocked.

Rub around right thumb with left palm.

Rub around left thumb with right palm.

Rub around fingers of right hand with palm of left hand.

Rub around fingers of left hand with palm of right hand.

Rinse off soap with clean, preferably running, water, and dry well.

ENVIRONMENT

Wear heavy duty gloves for all cleaning procedures.

Clear up any spillages of blood or other body fluids immediately, then
- Cover with bleach and leave for 15 minutes.
- Wipe with disposable paper tissue or cloth.
- Wash the surface with a clean cloth, detergent and water.
- Burn all cleaning tissue and cloths.

Burn or bury soiled materials and other waste.

Soiled linen: soak first, dispose of the water carefully, and boil the linen before (gloved) hand-washing.

CLINICAL PRACTICE AND SAFETY ISSUES

Eye drops and ointments: provide individual containers for each patient.

Eye dressings: following removal, dispose of immediately by burning.

Eye shields: if removed from a knowingly infected patient, never re-use.

Pathological specimens: dispose of needles and blades which are used to obtain corneal and conjunctival material into sharps container.

Wear rubber boots to protect feet in the operating theatre.

Wear a plastic or rubber apron under sterile gown if large amounts of blood spillage are expected.

Wear eye protection and face masks in the operating theatre.

Wear gloves on both hands for all invasive procedures and when in contact with broken skin, mucous membranes, blood and body fluids.

EQUIPMENT

Used needles and other sharps: dispose of immediately into a puncture-resistant container. Make sure plenty are available in all areas where needles are used.

Never re-sheath a disposable needle. One third of needle stick injuries are reported to occur during re-sheathing.

If a needle stick injury occurs, remove the glove and instrument from the surgical field. (See below for procedure following a needle stick injury).

Applanation tonometer prisms (tips only), diagnostic contact lenses, A-scan probes, occluders and pin-holes should be wiped with disposable paper tissue after each use. Store in sodium hypochlorite 1% in a non-metallic pot for 10 minutes, rinse in sterile water and dry before re-use.

Slit lamp: chin rest, head rim, handgrips and table top should be washed with detergent and water between each patient examination.

In the event of a needle stick injury

- **Allow the wound to bleed freely for a few minutes.**
- **Wash with soap and water.**
- **Cover with a sterile dressing.**
- **Note the details, if known, of the person on whom the needle was used, and if possible check their HIV status.**
- **Report the incident to the person in charge.**

The injured person should be examined by a medical practitioner and referred for treatment if HIV transmission is a confirmed risk.

Remember!

Control of infection principles must be applied in each and every situation, and not only when infection hosts are known or suspected.

The risk of HIV transmission after a single needle stick injury is small; the overall risk is about 3 per 1,000 injuries. HIV remains the least likely occupational infection to be transmitted, but still causes the most anxiety. Health care workers may become complacent about other serious and more likely risks.

The prion diseases, *eg* Creutzfeldt-Jakob Disease (CJD), also give genuine cause for concern. CJD is resistant to most sterilization methods. The only guaranteed measure to prevent CJD cross-infection is the use of sterile, single-use disposable instruments.

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(References are available on request).
Acknowledgements – *Photos*: **Murray McGavin** (People, Environment, Clinical Practice); **Ingrid Cox** (Equipment, Decontamination Procedures); **Sue Stevens** (Hand Washing). *Design layout:* **Bernard Boase**.
Supported by **Sight Savers International, Christian Blind Mission International**, and **Dark & Light Blind Care**.

Sterilization and disinfection

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Good surgical results are dependent upon sterile instruments in good working order used by skilled people who care.

This article gives an overview of the principles and guidelines for the methods of sterilization and disinfection which can be used for ophthalmic instruments. It has been stimulated by the many enquiries received by the International Resource Centre at the International Centre for Eye Health regarding the need for information on this topic. The authors, who have also produced an expanded text on ophthalmic operating theatre practice[1], hope this overview will help enquirers, and others, to set the necessary standards ensuring good practice in even the remotest of eye clinics. John Sandford-Smith, in his book *Eye Surgery in Hot Climates*, insists that there 'be no compromise in considerations regarding sterilization and instrument care.'[2]

The responsibility for sterilization, disinfection and prevention of cross infection in a clinical situation is very great and lies with everyone involved on the health care team. Traditionally, it has been accepted as a nurse's role. Whoever has ultimate responsibility, however, will be well advised to ensure that policy and ground rules are followed by every team member. Each member must be aware of the importance of infection control and the team leader will need to reaffirm policy periodically. Perhaps the most important factor in policy making is to recognise that the methods of sterilization and disinfection chosen must be appropriate to the individual situation, in terms of cost and availability, as well as in terms of the clinical needs. Re-evaluation is necessary from time to time because, despite the most stringent following of rules and the safest of practice, complications still occur, sometimes to the detriment of patient care and staff safety.

Fig 1. Metal sterilizing drums *Photo: Ingrid Cox*

Glossary

Antiseptic: Chemicals which can kill micro-organisms or prevent them multiplying, without being harmful to human tissue.
Asepsis: Ensuring the absence of micro-organisms.
Aseptic technique: Procedure used to prevent micro-organisms reaching the operation site.
Autoclave (steam sterilizer): Container used for sterilization which is designed to withstand steam at high pressure.
Bowie Dick test: A test to ensure that air has been removed and full steam penetration has occurred during autoclaving A cross is made with autoclave tape on a sheet of steam-permeable paper or drape which is placed in the middle of a stack of cotton towels and all then put through the sterilization cycle. The complete and uniform change of tape colour indicates satisfactory steam penetration. It does not, however, guarantee that sterilization has been achieved.
Corrosion: Gradual eating away by degrees of any metal surface by rust or othe chemical reactions.
Contamination: The introduction of micro-organisms and foreign mater into sterile materials or living tissue. (Note: Therefore, a 'contaminated instrument' is '<u>not</u> sterile'!).
Decontamination: The process of rendering an item free from infection, e.g., a surgical instrument.
Detergent: a substance, usually dissolved in water, used as an aid for cleaning purposes.
Disinfectant: A chemical used to kill some pathogenic micro-organisms. (Note: some disinfectants are harmful to human tissue.)
High level disinfection: Achieves disinfection but does not kill spores.
Dry heat: Air heated to a high temperature by electricity and used, at high temperatures, for sterilizing purposes.
Infection: The invasion, establishment and growth of micro-organisms in living tissue.
Micro-organisms: Bacteria, viruses, fungi and spores.
Moist heat: Heat produced by steam at high temperature and under pressure
Pathogenic micro-organisms: Micro-organisms capable of causing infection
Spores: The seeds of micro-organisms which are resistant to dryng, heat and disinfectants.
Sterilization: The complete destruction of all types of infective micro-organisms.

Note: It is essential that all instruments are cleaned thoroughly with a suitable detergent and water, at a reasonable temperature, and gentle brush, e.g., toothbrush, and rinsed in clean water before using any of the methods discussed. Cannulae must be flushed through with the detergent and water, followed by clean water, before sterilizing.

PHYSICAL METHODS

- Steam under pressure
- Dry heat
- Ionising irradiation
- Boiling

Autoclaves

These sterilize by *steam under pressure*. The temperature setting and sterilizing time is dependent on the type of autoclave and articles being treated. It is important to follow the specific manufacturer's instructions very carefully. The recommended time and temperature relationships for steam sterilizers are 134° C for 3.5 minutes or 121°C 15 minutes. However, the total cycle time will be longer than the sterilizing times quoted to enable the various stages of the cycle to be achieved. The complete cycle can take up to 45 minutes which includes drying time.[3] Articles can be placed in metal sterilizing drums with holes to allow for steam penetration (Fig. 1). These articles should, ideally, be used within 24 hours of being sterilized but this is not always practical in rural hospitals where autoclaving cannot be done daily.

Alternatively, items may be double wrapped, for porous loads only, and marked with autoclave indicator tape – a change from beige to brown coloured lines indicates the desired temperature and pressure has been achieved. (The indicator tape is sensitive to sunlight and should, therefore, be stored appropriately.) These items have a shelf life of eight weeks, if wrapped in polythene after cooling, and should be marked within the date of autoclaving and packer's name.[4 5]

If dampness of drapes and gowns, etc., is noted when they are removed from the autoclaves they must not be used as this indicates a faulty cycle and sterility has not been achieved.

Many varieties of autoclaves are available. Choice is dependent on suitability for local needs.

'Little Sister' Autoclaves

This equipment is also effective for sterilization using ***steam under pressure***. These autoclaves are small enough to place on a work surface, bench top, shelf or trolley and are particularly useful for re-sterilizing instruments during operating sessions, e.g., if contamination has occurred or for subsequent cases. It is extremely important to wash all cannulae and other lumens thoroughly with detergent and water, before placing in a 'Little Sister', otherwise nay debris will prevent steam penetration.

Portable Autoclaves and Domestic Pressure Cookers

These also sterilize by ***steam under pressure*** and are useful in theatres for sterilizing sets of instruments. They are very quick, efficient and popular in rural areas.

Safe practice points to ensure quality control in autoclaving:

- Operating instructions for the particular autoclave must be read carefully and followed exactly. Times and temperatures are variable.
- Because of varying sterilization times for different items it is recommended that similar items are placed together.
- Instruments must not be left in an autoclave for longer than necessary as this will cause corrosion.
- The steam must penetrate the contents and, therefore, the autoclave must not be packed tightly.
- Distilled or rain water should be used for filling the autoclave. It is very important to check that the distilled water is at the correct level in the reservoir before using.
- Rubber items should be powdered to prevent disintegration.
- Instrument tips should be protected, e.g., with silicone tubing.
- Porous-load items must be double wrapped, marked with indicator tape and date of autoclaving, and also the packer's name.
- A 'Bowie Dick Test' should be done on porous-loads to ensure that full steam penetration is being achieved. Ideally, this is advised daily but is not usually practical. Weekly tests, at least, are acceptable.
- Training sessions for staff responsible for autoclave maintenance should be provided at regular intervals.
- Spare parts should always be available.
- Sterilizing drums must be 'open' during the cycle and 'closed' on completion.

Hot Air Ovens

These fan-assisted ovens sterilize by ***dry heat*** and are often used in larger, central medical centres. They are not suitable for rural use. The sterilizing time is 2 hours but the complete cycle is 4 hours and, therefore, only of use where there is no shortage of surgical instruments. These, if wrapped in polythene, have a shelf life of 8 weeks. Hot air ovens are useful for drying washed instruments.

Ionising Irradiation

This method of sterilization is used commercially by large manufacturing companies especially for syringes, needles and suture material. It is very expensive and usually available only to tertiary centres.

All the methods discussed above achieve ***sterilization*** and therefore all micro-organisms, including the AIDS virus, are destroyed using these methods. Many others are often referred to as 'sterilizing methods' but, as the text below will show, many only achieve ***disinfection***. The words cannot be used interchangeably.

Boiling

High-level disinfection is achieved by ***boiling***. Instruments must be completely immersed in already boiling water in a container, preferably with a lid.[6] It is better to use distilled or rain water. Boil at 100°C for a minimum of 10 minutes. Although probably the most readily available method, it has the distinct disadvantage of blunting instruments. Instruments must not be placed on top of each other. A silicone mat on the bottom of the container will help to protect the instruments. Silicone or intravenous tubing will also protect the tips of fine instruments.

Boiling kills bacteria, fungi and viruses, including the AIDS virus, but not spores.

It is bad practice to place boilers, or autoclaves, on the floor or at a level where they may be a safety hazard. Boiling pans at floor level defeats the purpose of the practice as debris can easily be kicked into containers which do not have well fitting lids. Considerable planning is necessary when organising a sterilizing area: there must be no margin for error and consequent risk for patients and staff.

Cheatle's forceps are used to remove articles from boilers and formalin cabinets (see below). The forceps are placed in a container of methylated spirit when not in use. Both forceps and container must be boiled before each theatre session.

CHEMICAL METHODS

- **Gas**
- **Vapour**
- **Soaking in liquid chemicals**

Ethylene Oxide (C2H40)

This ***gas*** is effective for almost all instruments and materials and especially for those which do not tolerate heat sterilization or soaking in chemicals. It is used for eye shields, ophthalmic probes, tubing and vitrectomy equipment. It is, potentially, extremely hazardous! The sterilizing cycle is lengthy (12 hours) and it is enormously expensive to set up and to run.[7] Special training for staff needs to be provided. Its use is, therefore, limited to large tertiary centres servicing a wide area and is not appropriate for routine use in most developing countries.

All micro-organisms are destroyed, including the AIDS virus.

Formalin

A cabinet containing formalin tablets can be used to sterilize instruments and also to store them. A cabinet may be made from an old refrigerator which can be adapted for this purpose or it can be made from a simple tin, depending on the size required, provided the receptacle is airtight. The area should be well ventilated (Fig. 2).

A heat source is required for the larger cabinet, and perforated metal shelves, to allow the ***vapour*** to circulate. Heat can be provided by an electric 25 watt light bulb above which a shelf holds the formalin tablets. The container needs to be kept at a room temperature of 20ºC. Sterilizing time is 12 hours. The cabinet must not be opened during this time.

Although this method is known to be practised widely in rural areas, its effectiveness is said to be uncertain. Formalin is an irritant to eyes and skin and precautions must be taken in handling. It is a known carcinogenic! Eye protection, if available, should be worn and cheatles must be used to remove instruments from the tin or cabinet. The use of formalin is not encouraged if alternative methods are available.

Safe practice points to ensure quality control when using formalin:

- Instruments must be dismantled, where possible.
- Sterilization must be done in a sealed airtight container.
- Requires 7 grams of formalin per cubic metre.
- Tin or cabinet must be left unopened for 12 hours and marked with the time and date it was sealed.
- Room temperature must be kept at 20ºC.
- Instruments must be rinsed in sterile water before use.

Good practice achieves destruction of all micro-organisms, including the AIDS virus.

Soaking in Liquid Chemicals

This method is used when alternative methods are unavailable or known to damage instruments and other materials. Long-term, it can cause problems, e.g., staining, corrosion and blunting of instruments. It is recommended that an anti-rush agent, e.g., sodium nitrite 0.1%, be added to the solution where applicable, and if available. Soaked instruments should be rinsed unde a 'stream' of sterile water before being used. It is not advisable to use chemical soaking for syringes, needles and other skin-cutting instruments.[8] Space will allow for only some of the most commonly used liquids to be discussed here. Manufacturers' instructions should always be followed carefully.

Glutaraldehyde 2%

Glutaraldehyde 2% has been used in many tertiary centres when heat sterilization is impractical and other methods are unavailable. It has been readily available in most parts of Africa. It was withdrawn from sale as from May 2002 on the advice of the Health and Safety Executive, UK. If overseas programmes continue to use this chemical, the following guidelines must be followed. Items must be totally immersed with no air bubbles present in a covered container for a minimum of 10 minutes, which achieves disinfection. Sterilization takes 10 hours. It is vital that manufacturers' instructions are followed as various proprietary names are now available. Thorough rinsing under a 'stream' of sterile water is extremely important! This is a corrosive chemical and a severe irritant if its vapour is inhaled or it comes into contact with the skin. The area should be well ventilated. Cheatles' forceps must be used to remove instruments. Corneal oedema has been reported in patients following the use of glutaraldehyde to sterilize cannulae used during cataract surgery. These cannulae and all lumens must be thoroughly irrigated with detergent and rinsed with sterile water.[9 10]

Shelf life (once activated): 14-28 days. (The various manufacturers' instructions must be followed).

The quantity used for soaking instruments must be changed according to the specific manufacturers' instructions.

It kills bacteria, spores, fungi and viruses, including the AIDS virus.

When all supplies have been used the recommended alternative, Perasafe, should be ordered (see table), although this is not yet available in all developing countries.

Isopropyl Alcohol 70%

Isopropyl alcohol 70% is available at low cost and ready to use, for disinfecting indirect ophthalmoscope lenses and metal instruments, including 'sharps'. It can also be used to disinfect the plunger and plate of a Schiotz tonometer and the tip of applanation prisms. It is not advisable to leave prisms soaking as it can cause damage to the plastic. Suitable receptacles are recommended.[11 12] Other items must be completely immersed.

When soaking, it is a rapid method taking only 2 minutes in a covered container.

If this agent is used for wiping tips of applanation prisms, it is recommended they are wiped dry after rinsing as corneal epithelium reaction has been reported.[13]

Extreme caution must be taken as this agent is highly inflammable.

The quantity used for soaking must be changed daily.

It kills bacteria, spores, some viruses including the AIDS virus, but not entero- or adenoviruses, or fungi.

Using Cheatle's forceps in a boiling pan.
Photo: Murray McGavin

Sodium Hypochlorite

Sodium hypochlorite is becoming more readily available.

To prepare: Add 500mls of sodium hypochlorite 1% to 1 litre of boiled water (rain water is preferred). This makes a total quantity of 1.5 litres.

Shelf life: 7-14 days.

The quantity used for soaking instruments must be changed daily.

Use a plastic or glass container only. Metal containers for shelf or soaking storage are not suitable as sodium hypochlorite is a bleach, highly volatile and corrosive. It must not be used to disinfect a Schiotz tonometer!

Items must be completely immersed in a covered container for a minimum of 10 minutes and rinsed under a 'stream' of sterile water before use.

Sodium hypochlorite kills bacteria, spores and viruses including the AIDS virus,[14] but not fungi.

Chlorhexidine

Chlorhexidine is readily available at low cost.

To prepare: Add 100ml of chlorhexidine gluconate 0.5% to 900ml of boiled water (rain water is preferred) and 1 gm of sodium nitrite (anti-rust agent). This makes a total quantity of 1 litre.

Shelf life: 7 days.

The quantity used for soaking must be changed daily.

It is suitable for disinfecting plastic, rubber and metal instruments but can cause blunting of scissors and knives. Items must be completely immersed in a covered container for a minimum of 10 minutes. They must be rinsed under a 'stream' of sterile water before use.

This method is effective against bacteria, spores and fungi but does not kill viruses.

Povidone Iodine

Povidone iodine aqueous solution 10% is probably the most popular and widely available disinfecting agent available to developing countries.

The powder has the great advantage of being very inexpensive, and very versatile. Caution is strongly emphasised in its preparation as varying strengths are recommended for individual practices. The disadvantages are that it stains fabric, surfaces and instruments and, because it is dark in colour, it is often difficult to see instruments in the liquid. Skin irritation has also been reported.[15]

To prepare: Add povidone iodine, 50gms; sodium phosphate, 16.6gms; citric acid (water free) 3.4gms; to 500ml of distilled or cooled boiled rain water.

Mix the citric acid and sodium phosphate first and then add 300ml of distilled water. Next, slowly add the povidone iodine in small portions until dissolved and lastly add the remaining 200ml of distilled water.

Shelf life: One month.

The quantity used for soaking must be changed daily.

Povidone iodine is effective against bacteria, spores, fungi, some viruses including the AIDS virus,[16] but not entero-or adenovirus.

It is also available commercially as the following:

BETADINE ANTISEPTIC SOLUTION 10% – for 'prepping' operation (skin) sites, other than ophthalmic.

BETADINE SURGICAL SCRUB 7.5% – a soap used for hand scrubbing.

Fig 2. Formalin cabinet in well ventilated room.
Photo: Ingrid Cox

BETADINE OPHTHALMIC PREPARATION 5% – for 'prepping' the peri-ocular region ad irrigating the ocular surface.

BETADINE EYE DROPS 5% are standard use in developing countries. Do not confuse the eye drops with other Betadine preparations!

Author's Comments

Specific equipment/manufacturers cannot be recommended. The choice and suitability of autoclaves, for example, will be dependent on:

Local conditions, e.g., base hospital or mobile unit needs.

Demands, e.g., surgical throughput.

Maintenance, e.g., spare parts, trained personnel, manufacturers' planned programme.[17]

Whilst it is always good to aim for the highest of standards, readers will recognise and appreciate the need to adapt practice to suit local facilities and situations.

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Updated: Feb. 2005. This article was first published in *Community Eye Health*, Vol 9, No. 19, 1996.

STERILIZATION AND DISINFECTION

A Reference for Ophthalmic Practice in Developing Countries

Method	Achieves	Timing	Destroys	Advantages	Limitations	Power Source	Suitable for	Minimum temperature
General autoclave	Sterilization	Approximately 45 minutes Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Low running cost Minimal maintenance Suitable for busy unit Drying cycle	Difficult to obtain spare parts in developing countries	Electric (single or 3 phase) Kerosene / Paraffin	All metal instruments Drapes Gowns Dressings Toughened plastic Glass	121°C
Bench top autoclave	Sterilization	20 minute cycle	Bacteria Spores Viruses Fungi	Quick and efficient Small, bench-top size Suitable for busy unit	High running cost Difficult to obtain spare parts in developing countries No drying cycle Sensitive to voltage fluctuations	Electric (single phase)	All metal instruments Toughened plastic Glass	134°C
Portable autoclave, Domestic pressure cooker	Sterilization	Minimum of 15 minutes Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Low running cost Quick and efficient Suitable for mobile units Spare parts usually readily available Minimal maintenance	Drying cycle unreliable Sensitive to voltage fluctuations Relatively small Various manufacturers whose instructions must be followed	Electric (single phase) Gas Kerosene / Paraffin Charcoal Wood	All metal instruments Drapes Gowns Dressings Toughened plastic Glass	121°C
Hot air oven	Sterilization	2 hour cycle	Bacteria Spores Viruses Fungi	Minimal maintenance Drying cycle	Expensive Slow Instruments get extremely hot and cannot be used immediately Must not be used in a confined space	Electric (single phase)	All metal instruments Toughened plastic Glass	180°C
Ethylene oxide C_2H_4O	Sterilization	Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Bulk quantities Suitable for delicate items and items which must be kept dry	Very expensive Dangerous, explosive Carcinogenic Only suitable for large tertiary centres with appropriate facilities	Electric with C_2H_4O gas cartridges	Plastic eye shields Ophthalmic instruments and probes Delicate tubing	Varies with type of equipment used
Formalin	Sterilization	12 hours	Bacteria Spores Viruses Fungi	Low running costs Suitable for delicate items that are susceptible to rust Cabinet can hold a large quantity of instruments Usually readily available	Airtight containers required Irritant to skin, to eyes and if inhaled Gloves and eye protection advisable Items must be rinsed in sterile water before use Slow	Electricity for heat source if a large cabinet is used (eg: an adapted refrigerator not used for cooling)	All metal instruments Toughened plastic Glass Delicate tubing	Room temperature 20°C Well ventilated
Ionising irradiation	Sterilization	Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Bulk quantities Suitable for delicate items and items which must be kept dry	Usually only available commercially and used by large manufacturing companies	Gamma rays	Needles Syringes Sutures Toughened plastic	

Boiling	High level disinfection	Minimum of 10 minutes	Bacteria Viruses Fungi	Low running cost Quick and efficient Easy to teach Suitable for all situations Minimal maintenance Readily available	Does not kill spores Blunts scissors and knives Causes rusting of instruments	Electric (single phase) Gas Kerosene / Paraffin Charcoal Wood	Heavy metal instruments Plastic Glass Needles Sutures	100°C

Method	Achieves	Timing	Destroys	Advantages	Limitations	Suitable for
Glutaraldehyde 2%	Sterilization Disinfection	Sterilization in 10 hours Disinfection in 10 minutes Follow manufacturer's instructions	Bacteria Spores Viruses Fungi		***(Withdrawn from sale May 2002)*** Irritant to skin, eyes and if inhaled Gloves and eye protection advisable May leave greasy residue Items must be rinsed and lumens irrigated thoroughly before use	All metal instruments Airways, endotracheal tubes and face masks Plastic Glass
Perasafe recommended alternative to Glutaraldehyde	Sterilization	10 minutes	Bacteria Spores Viruses Fungi	Non-corrosive No toxic vapour No requirement for ventilation, air extraction or protective clothing Environmentally safer	Not yet fully available in all developing countries Equipment must be well rinsed and flushed through with sterile water Not suitable for indirect ophthalmoscopy lenses or applanation prisms	All metal instruments including heat sensitive endoscopes, airways, endotracheal tubes and anaesthetic face masks A more dilute version can be used as a disinfectant cleaning solution and for soaking contaminated linen Follow manufacturer's instructions
Isopropyl alcohol 70% (Methylated spirit)	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Viruses (but not entero or adeno viruses)	Low cost Readily available Good for use on indirect ophthalmoscope lenses	Highly flammable Corrosive (do not leave metal instruments soaking longer than 10 minutes) Tonometry items must be rinsed and wiped before use Evaporates Does not kill entero or adeno viruses	All metal instruments Mechanism of Schiötz tonometer and applanation prism tip Indirect ophthalmoscopy lenses
Sodium hypochlorite	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Viruses	Becoming more readily available Reasonable cost	Highly volatile and corrosive (do not use metal container to soak items) Bleach	Indirect ophthalmoscopy lenses Applanation prisms; only the tip of applanation prism should sit in solution, and must be rinsed and wiped dry before use on the eye
Chlorhexidine	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Fungi	Low cost Readily available	Evaporates Does not kill viruses Blunts scissors and knives	Metal instruments Plastic Rubber Mechanism of Schiötz tonometer and applanation prism tip
Povidone iodine	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Viruses (but not entero or adeno viruses) Fungi	Low cost Readily available Versatile	Stains fabrics and surfaces Discolours instruments Solution is dark, difficult to see items in soak Irritant to skin Does not kill entero or adeno viruses	All metal instruments Sutures Blades

INTERNATIONAL CENTRE FOR EYE HEALTH

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This poster highlights the main principles discussed in a full article in *Community Eye Health Journal*, Vol 9, Issue Nº 19, 36-42, 1996, and in *Ophthalmic Operating Theatre Practice – A Manual for Developing Countries*, ICEH, 2002.
Supported by **Sight Savers International, Christian Blind Mission International**, and **Dark & Light Blind Care**.

Low vision devices and training

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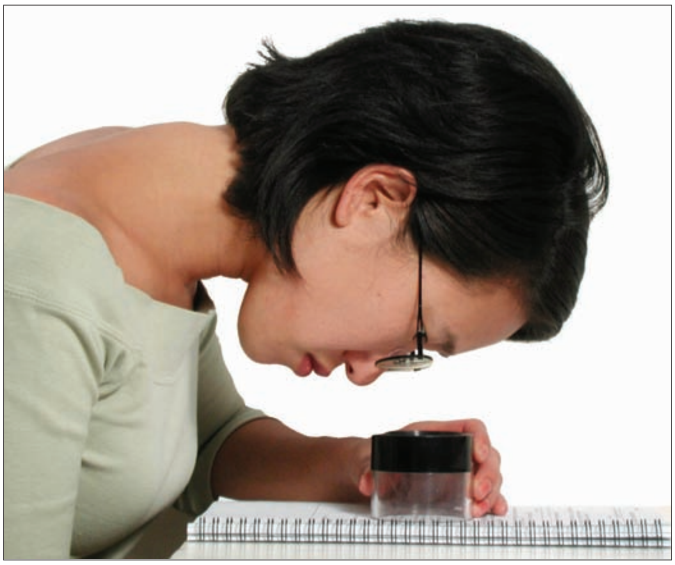
Introduction

Vision is the ability to see with a clear perception of detail, colour and contrast, and to distinguish objects visually. Like any other sense, vision tends to deteriorate or diminish naturally with age. In most cases, reduction in visual capability can be corrected with glasses, medicine or surgery. However, if the visual changes occur because of an incurable eye disease, condition or injury, vision loss can be permanent. Many people around the world with permanent visual impairment have some residual vision which can be used with the help of low vision services, materials and devices.[1] This paper describes different options for the enhancement of residual vision including optical and non-optical devices and providing training for the low vision client.

Low Vision Devices

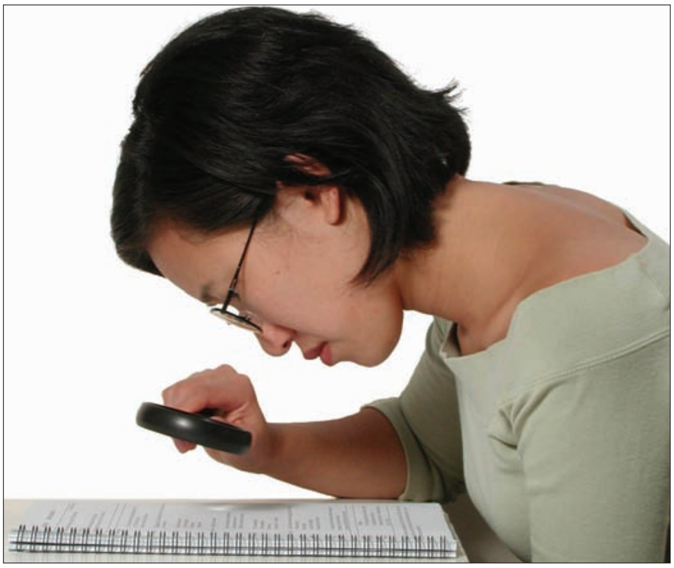
There are several ways in which an image can be enlarged for a low vision client:

- ***optical magnification*** – magnifying the object by means of a lens or combination of lenses i.e. magnifiers and telescopes
- ***relative size magnification*** - increasing the size of the object, for example large print books or televisions with larger screen size



Stand magnifier

Photo: Sarah Squire



Hand-held magnifier

Photo: Sarah Squire

- ***relative distance magnification*** - reducing the distance of the object, for example, moving the reading material closer to the eye or going closer to the writing board.

Optical Low Vision Devices

Optical devices consist of one or more lens placed between the eye and the object to be viewed, which increase the size of the image of the object on the retina. Low vision devices work on the principle of optical magnification and provide an enlarged image of the object.

- Magnifiers

Magnifiers can be prescribed as hand-held, hanging, stand, illuminated hand-held, illuminated stand, spectacles or bar and dome magnifiers. Spectacle magnifiers are the most commonly prescribed magnifiers. They come as full aperture, half-eye, or bifocal with base in prisms for binocular viewing.

- Telescopes

For people with low vision, telescopes with magnification powers from 2x to 10x are prescribed. These are prescribed for distance, intermediate and near tasks. Types of telescope include hand-held, clip-on, spectacle mounted and bioptic designs. Traditionally the power of low vision devices is denoted as x, which means the relative increase in the image size to the object size. For example a 2x would mean an increase in the image size by two times. As different manufacturers use different methods to calculate this, there is a growing trend to move away from this labelling and denote the powers of magnifiers in dioptres or as equivalent viewing distances (EVD).

- Glare Control Devices

As glare may be a significant disabling factor in many eye conditions, tinted lenses are routinely prescribed along with 'caps', 'hats' and visors. Absorptive filters are tinted lenses, which are used to counter glare. They come in different tints at various levels of absorption and different cut-off points for the visible spectrum of light.

For an accurate and appropriate final prescription, the low vision clinic should have a range of magnifiers, telescopes and absorptive filters.

Non-Optical Low Vision Devices

Non-optical devices are items designed to promote independent living. They alter environmental perception through enhancing illumination, contrast and spatial relationships. A useful slogan to remember the key to non-optical devices is 'Bigger, Bolder, Brighter'. Devices may include illumination devices such as lamps and reading stands, check registers, writing guides, bold-lined paper, needle-threaders, magnifying mirrors, high contrast watches, and large print items such as books.

To provide advice on non-optical devices, there should be a range of options available for demonstrating and training the client in their use. This advice can be given by any appropriately trained eye care worker.

Electronic Devices

For people with severe visual loss, electronic devices are an option. There are two types; optical devices which display the task in a magnified form from a television monitor, and non-optical electronic devices which are conversion systems that convert text into a speech system.

- Closed Circuit Television

Electronic optical devices make use of a zoom television camera to magnify materials onto a television screen. They are called closed circuit televisions (CCTVs). The advantage of a CCTV is in its greater amplitude of magnification of 3x to 100x, normal working distance and reversed polarity (e.g. white on black). The disadvantages are the cost and the bulk of the system that makes it quite immovable.

- Conversion Systems

Non-optical electronic devices include talking watches, talking calculators and speech and Braille conversion systems.

With further developments in electronics, more and more devices are becoming available for people with low vision. It is important to keep up-to-date with these developments so that the best options can be offered to clients with low vision.

Training: Equipping Low Vision Clients with Skills and Confidence

Functional vision may be improved with training. Many people can learn to make better use of their low vision and can function efficiently with only small amounts of visual information. Objects and print can be recognised when they are blurred or when only parts of them can be seen. Visual functioning plays a very significant role in promoting independent living in people with low vision. Whether the disability is mild, moderate, severe or profound, if people with low vision are given proper training in visual skills, they more often than not show an improved performance in their day to day activities and move closer to leading an independent life.

Essentially, there are two types of training:

- ***Effective use of residual vision*** by teaching the client visual skills such as eccentric viewing, tracking, scanning and pursuit movements. There are many exercises and training programmes available for clients
- ***Use of prescribed devices*** especially telescopes and magnifiers.

The final advice and prescription need to conform to the client's needs, and should be culturally appropriate, affordable and accessible.

How to Access Resources for Low Vision Devices

One of the major impediments to providing low vision services has been the high cost of low vision devices available on the market. The Low Vision Resource Centre of the Hong Kong Society for the Blind now supplies low vision devices and assessment materials at affordable cost to developing countries. The new Centre has catalysed development of low vision programmes in many countries and is likely to have an even greater impact in the future. The LVDs and the assessment materials and equipment listed in the Recommended Standard List (page 8) are available from the VISION 2020 Low Vision Resource Centre of the Hong Kong Society for the Blind. The catalogue is on www.hksb.org.hk or by e-mail: drd@hksb.org.hk. Address: Hong Kong Society for the Blind 21F, Headquarters Building, East Wing 248 Nam Cheong Street, ShamShui Po, Kowloon, HongKong.

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First published in *Community Eye Health* Vol. 17 No. 49 2004; pp. 6–7.

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Standard List for Low Vision Services: VISION 2020 Low Vision Group

Ophthalmic Equipment	Tertiary Level Low Vision Clinic	Secondary Level Low Vision Clinic
Streak retinoscope	✓	✓
Direct ophthalmoscope	✓	✓
Lensmeter (Focimeter)	✓	
Trial lens set (full aperture)	✓	✓
Universal trial frames	✓(2 sets)	✓
Paediatric trial frames (2 pairs of different sizes)	✓	✓
Trial lens holder	✓	
Halberg clip	✓	
Long handle occluder with pinholes	✓	✓
Cross cylinders (±0.5, ±1)	✓	
Pen torch and measuring tape	✓	✓
Vision Assessment Equipment		
Light box for visual acuity test	✓	
Distant LogMAR test charts – letter, number, tumbling Es, Landolt Cs (one of each type)	✓	✓
Near vision tests (same as distant but calibrated for 40 cm) Reading acuity test (continuous text in English and local language)	✓	✓
Symbol paediatric tests for matching and pointing (with and without crowding)	✓	✓
Preferential looking system	✓	
Contrast sensitivity test charts	✓	✓
PV-16 Colour Vision Test (double set)	✓	
'Amsler' grids	✓	
Hand disc perimeter	✓	
Tangent screen	✓	
Optical Low Vision Devices		
Spectacle magnifiers (half eyes)	6D to 12D in 2D steps with base in prisms 10 to 40D in 4D steps as half eye; total 9 pieces 10 to 40D in 4Dsteps as full aperture R+L; total 18 pieces	6D to 12 D in 2D steps 16D to 20D in 4D steps; total 6 pieces
Foldable and hand-held magnifiers with and without built-in light source	5D to 42D, total 15 pieces	5D to 17D; total 5 pieces
Stand magnifiers	with and without built-in light source, from 13.5D to 56D; total 9 pieces	with no built-in light source, from 13.5D to 40D; total 6 pieces
Dome and bar magnifiers	total 4 pieces	total 2 pieces
Hand-held monocular telescopes	2.5X, 3X, 4X, 6X, 8X and 10X with micro-lens for 8X and 10X telescopes; total 5 pieces	4X to 8X with micro-lens for 8X telescopes; total 4 pieces
Filters	of 5 different shades with UV protection and luminous transmission of 40%, 18%, 10%, 2% and 1%	of 4 different shades with UV protection and luminous transmission of 40%, 18%, 10% and 2%
CCTV Devices		
Colour television (20 inches)	✓	
Black and white hand-held CCTV magnifier	✓	
Full colour hand-held CCTV magnifier	✓	
Computer Devices		
Computer with laser printer and scanner	✓	
Computer software with text enlargement and voice output	✓	

	Standard List for Primary Level Low Vision Care
Ophthalmic Equipment	Pen torch
Vision Assessment Equipment	WHO Low Vision Kit
Low Vision Devices	4hand held magnifiers from 5D to 14D; total 4 pieces 4 stand magnifiers from 13.5D to 40D 2 telescopes, 4x and 6x

The approximate costs to equip clinics at the three levels are:

Tertiary:	US$ 14,000
Secondary:	US$ 4000
Primary:	US$ 100

Measuring vision in children

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Vision Support Teacher, Joseph Mwangi, testing fixation with a penlight
Photo: Petra Verweyen

Introduction

Measuring vision in children is a special skill requiring time, patience and understanding. Methods should be adapted to the child's age, abilities, knowledge and experience. Young children are not able to describe their vision or explain their visual symptoms. Through observation, and with information from the mother or guardian, functional vision can be evaluated. While testing and observing children, an experienced assessor notices their responses to visual stimuli. These must be compared with the expected functional vision for children of the same age and abilities, so it is important to know the normal visual development.

Normal Visual Development and Functions

In normal visual development, children start by observing their mother's face. Experiences of space, distances, and hand-eye coordination are important steps in stimulating the development of all visual functions during the critical period from birth to five years. Deprivation disturbs this development and may lead to 'nystagmus'(pendular, mainly horizontal, involuntary eye movements). Amblyopia or 'lazy eye' is another condition that can result from visual deprivation in early childhood.

Major visual functions which can be tested from a very young age include:

- pupil reaction
- motility
- fusion
- fixation
- visual acuity
- colour vision

The most important visual function is visual acuity. If a child has eye problems, visual acuity should be measured as soon as possible. This will indicate if vision is developing normally. It is not always possible to obtain a quantitative measurement of a child's visual acuity. However, a qualitative assessment by an experienced observer can be very useful. Although a qualitative assessment will show if a child is blind or not, it will not detect unilateral poor vision.

Key Points for Measuring a Child's Vision

Prepare for the assessment and assemble all the testing materials in advance so that the assessment can proceed without interruption.

Create rapport

Speak in a language he or she will understand. If you only talk to the mother, the child will lose interest. To get accurate results, the child needs to feel comfortable so that you have his or her full co-operation. If the child is sick, crying or hungry it may be better to postpone the assessment, even for half an hour. Small children may do better if they sit on their mother's lap. Explain the testing procedures to the mother and let her conduct the test while you observe the child.

Gain attention

To get the child's attention, try using an interesting object. This could be a torch or a coloured light, achieved by shining a torch through coloured plastic or cloth. Large objects with high-contrast forms activate visual pathways more effectively than light without forms. Sounds can also be used such as a small tin with rice inside. In this case, auditory attention is used first to reinforce the visual attention, but this is obviously not appropriate if testing a deaf child. When attention is achieved (which is sometimes only for very short periods) observe the child's behaviour. Does he look towards the object, is there nystagmus, does she reach for the object?

Test fixation

Observe the corneal reflexes with a torch. While testing fixation under monocular conditions the corneal reflex should be central; if not, eccentric fixation is present. It is important to note that fixation to bright light can be different from fixation at an 'accommodation requiring' fixation target. If you notice nystagmus, describe the type, form and amplitude so that you will be able to compare changes (improvements) during follow-up visits.

Identify the preferred fixating eye

In cases of squint it is easy to detect the preferred eye, as it is mostly in a straight position. If there is no squint you can use the vertical prism test to induce a vertical deviation. To be

Vision Therapist, Melioth Njeri, testing vision with the Cardiff Test
Photo: Petra Verweyen

sure of the result you should repeat it four times, prism base up and down on each eye. If there is no obvious dominance the preferred fixating eye is always the one behind the prism. A simpler test is to close one eye at a time and compare the reaction of the child. The child will be less co-operative while covering the dominant eye.

Estimate motility / visual field

Move an object of interest in different directions and observe the movements of the eyes. If you show objects suddenly (like in a game of hide and seek) you can observe fast saccades, spontaneous fixation, and also estimate the visual field. If these objects are not noticed, use brighter or bigger ones.

Test convergence and accommodation

Move an object gradually towards the eyes to induce inward movements of the eyes. These should be possible up to about 10 - 5 cm in front of the eyes. Children who are not interested in near objects should be checked with plus-lenses which may produce a good response.

Test visual acuity

Refractive error has a greater effect on visual acuity than any other visual function and should be corrected before measuring visual acuity. In older children you can use the pinhole test. Sometimes it is worth testing visual acuity at different distances (3/2/1 metres) to get an indication of refractive error or to find out if the current glasses are satisfactory. The vision must be tested using one eye at a time, and binocularly, with both eyes open. While testing vision binocularly look for abnormal head postures.

Pre-verbal children cannot describe what they see, so they are tested using 'preferential looking' techniques. Children will automatically look towards shapes and lines rather than a plain grey surface. These tests are used by an experienced observer to estimate the visual acuity value.

Testing vision at near distance with small objects (detection vision)
Photo: Petra Verweyen

Testing vision at near distance with a Bust card matching picture and object
Photo: Petra Verweyen

In the youngest children (0–24 months) we use grating acuity. This can be tested with the **Lea (paddles) Gratings**. These tools have black and white stripes of different widths. The thinner the stripes recognised, the better the grating acuity. Two paddles are moved from the midline with equal speed in front of the child, one grey and the other with stripes. If the child is able to recognise the stripes she will turn her head towards the movement of the striped paddle.

The **Cardiff Test** is good for slightly older children (18–60 months). It consists of different cards, which are held in front of the child. Each has a picture in the upper or the lower part of the card. If the child looks towards the picture on the card, you note the size as detected. If the child has good hand-eye coordination you can test detection vision with small objects made from modelling clay or similar materials. The child is requested to choose objects in front of her. The size of the smallest object picked, in combination with the distance, can be calculated into an approximate visual acuity value used to describe the minimum discernible.

If the visual acuity is very low, vision can be tested using optokinetic nystagmus. A striped object, either a rotating drum or a tape measure, is moved in front of the eyes. When the nystagmus is induced you know the child is able to detect the different stripes. The distance can be increased and you can observe and describe the distance up to which the nystagmus is still present. The presence of optokinetic nystagmus may not exclude loss of vision due to brain injury.

If children are able to recognise and describe pictures or symbols, specific visual acuity tests can be used. These are designed for near and far distance. As children are near orientated the test should be performed at near, and distance visual acuity measured at no more than three metres.

The Lea Symbols Test is useful because the symbols are easy to name and recognise. If the child does not speak you can use the key card. An advantage of the test is that the child never 'fails', as the symbols are designed to resemble each other, and the child will always have an answer. Children can be trained to function in the test situation at the age of 18–24 months by using the Lea Puzzle. It is better to use a line-test, with several symbols in each line, as single symbols are less useful for detecting amblyopia. In order to refer test results to defined values, specially designed tests should be used according to their instructions.

Test binocular vision

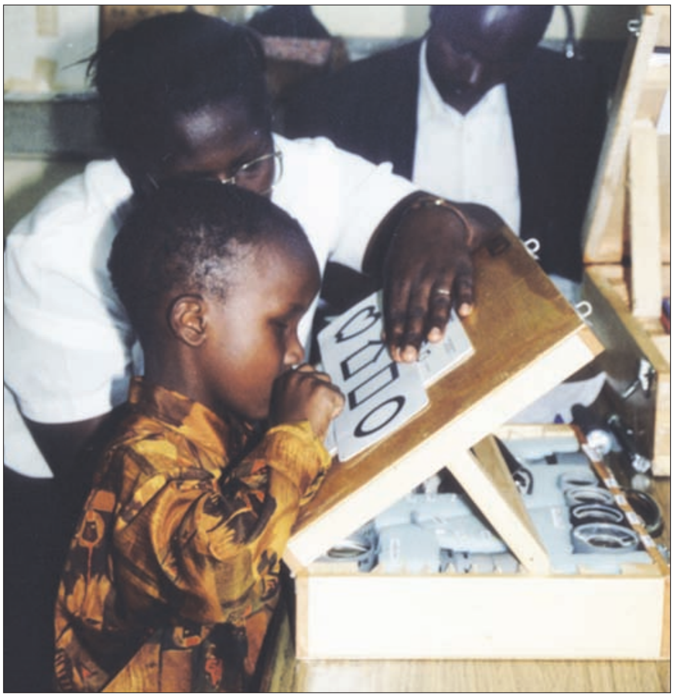
Binocular vision can only develop when the eyes are aligned and function equally. Binocularity can be tested at different levels with tests like **Bagolini Lenses, Lang Test Titmus Test** and **TNO Test**. If the child is not cooperative enough to conduct these tests, fusion can be checked with prisms. A 20 dioptre base-out prism is put in front of one eye while shining a penlight. If the eyes adjust to the prism and the corneal reflexes become straight, fusion is present which proves the existence of binocular vision.

Test colour vision

Assessment is not possible at a very young age but full colour vision develops very early. The easiest colour test for children is the matching of coloured objects.

Conclusion

Measuring vision in children is a comprehensive task. For diagnostic purposes, follow-up and evaluation of visual impairments, all elements should be considered and compared with the visual function of daily life. Results need to be explained and discussed with the parents or guardian to help them understand the situation and strengthen interaction with their children. This will reduce the visual disability, especially if the vision cannot be improved through medical treatment.



Vision Therapist, Agnes Ireri, testing near distance vision with Lea symbols

Photo: Petra Verweyen

Acknowledgements

I would like to thank Dr Lea Hyvärinen and Professor Siegfried Priglinger who assisted in editing this article and contributed to my professional knowledge, enabling me to perform measurements of vision in children more accurately. I am grateful to Dr David Yorston who supported my work with children in Kenya and also provided valuable comments in the preparation of this article.

Additional Reading and Resources

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First published in *Community Eye Health* Vol. 17 No. 50 2004; pp. 27–9,

Optical services for visually impaired children

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An estimated 1 in 250 children are visually impaired as a result of eye disease. Some of these children have nearly normal vision, some are totally blind, but the majority fall into a broad range between these two points. Children are said to have 'low vision' or 'partial sight' when they have: (a) a corrected visual acuity in the better eye of <6/18 to 'perception of light' (or a visual field of less than 10 degrees); and (b) the ability to use their residual vision to orientate themselves or to perform tasks.[1] They are identified at eye clinics, school screening programmes, community based rehabilitation (CBR) programmes, or special schools for the visually impaired.

The education, employment prospects, independence and quality of life of a child with low vision can all be improved by enhancing vision. Optical devices (spectacles, magnifiers and telescopes) play a key role in achieving this. Studies carried out in East Africa,[2] South America[3] and West Africa[4] indicate that approximately half of children who have low vision show an improvement in distance and/or near visual acuity, with the help of spectacles, a magnifier or both. The majority of magnifiers are prescribed for children who have a visual acuity in the better eye of <6/60 to 1/60.[3,4]

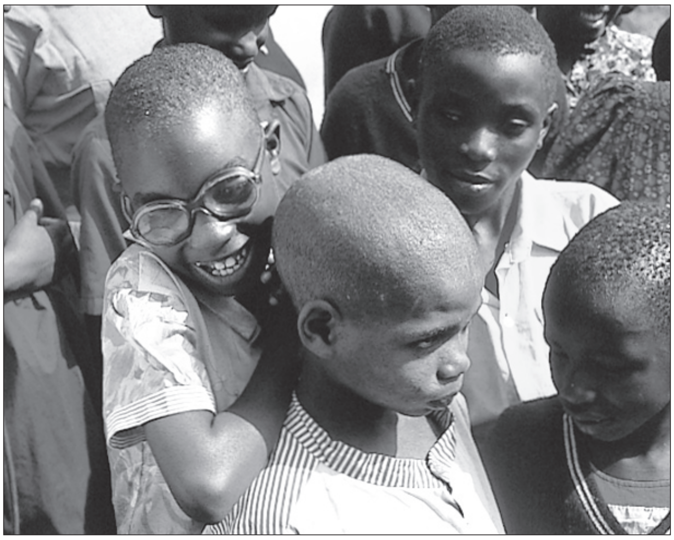
The Role of Optical Services in the Management of Children with Low Vision

The management of children with low vision requires co-operation between the child, his/her family and eye care educational and social personnel. There are five stages in the management of children with low vision (Figure 1). Eye care personnel are primarily involved in the assessment and monitoring stages, which include: a) visual acuity measurement (distance and near); b) eye examination, diagnosis and prognosis; c) surgical and/or medical treatment and, d) the provision of optical services.

Sight is a key source of stimulus during a child's development, and so children with low vision should be motivated to make the maximum use of their residual vision. This can be done using both non-optical and optical methods.

Enhancing Vision using Non-optical Methods

- Move CLOSER, e.g., use an angled reading desk
- Use COLOUR to show objects more clearly
- Use CONTRAST, e.g., eat white rice off a coloured plate
- Pay attention to LIGHTING, e.g., sit near a window in class
- Make objects LARGER, e.g., write with larger letters
- Use a LINE-GUIDE, such as a ruler, when reading and writing.



Accurate refraction and spectacle correction help many children with low vision

Photo: Murray McGavin

Enhancing Vision using Optical Devices

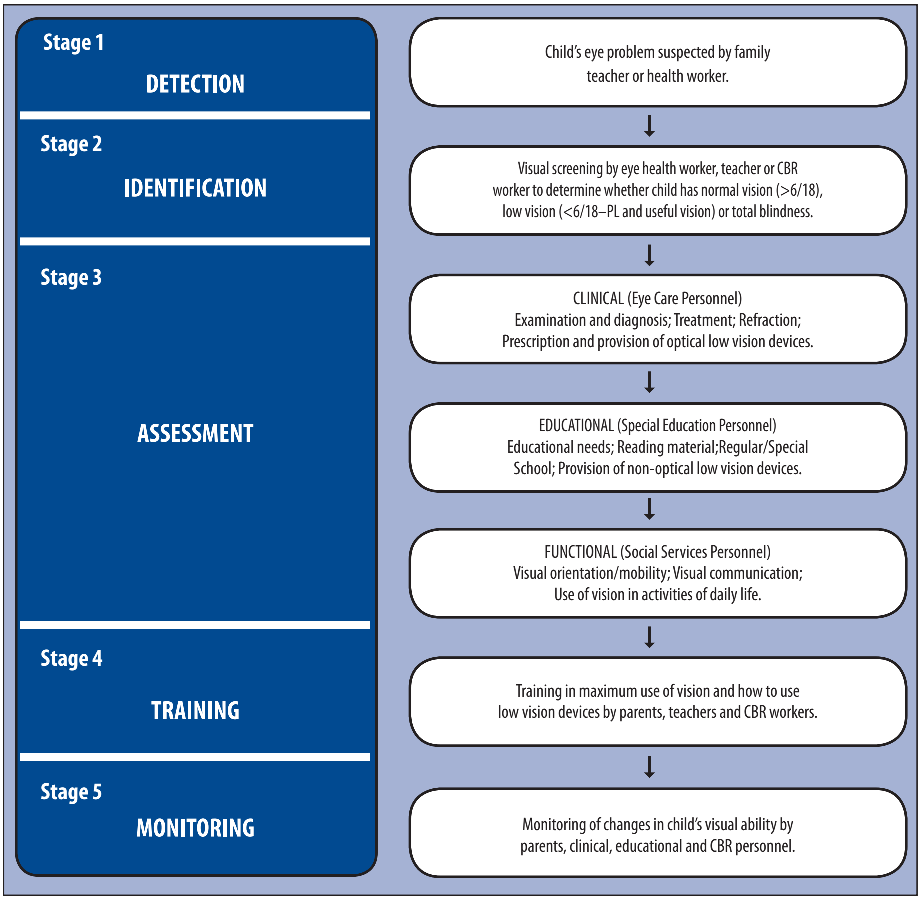
Optical devices play a key role in enhancing vision and reducing visual disability in children with low vision. They include: standard prescription spectacles; optical low vision devices for distance vision; and optical low vision devices for near vision.

(*a*) ***Standard prescription spectacles:*** It is important to ensure that children with low vision are refracted and provided with any spectacles they require. Work in West Africa indicates that at least 30% of children with low vision need spectacles.[4] Refraction should always be carried out before a magnification assessment.

(*b*) ***Optical low vision devices for distance vision:*** Distance vision magnification requires a telescopic lens system. Telescopes are expensive and have limited applications. It is often more practical for a child to sit near the front of class to see the backboard than to use a telescope.

(c) Optical low vision devices for near vision: An optical low vision device for near vision uses one or more lenses placed between the eye and an object, to alter the retinal image size of the object. This makes the object larger and easier to see. The minimum dioptric power of a device used in this way is +4.00D. These devices are inexpensive and have a wide range of applications. They play a vital role in giving children with low vision access to print and illustrations in standard text-books.

Fig.1: Stages in the Management of Children with Low Vision



Prescribing Magnifiers for Near Vision

The ***power*** of magnifier prescribed for a child is determined by the child's visual requirements, recorded near visual acuity and measured working distance. They are prescribed, starting with low power magnifiers and then progressing to higher powers. The higher the power, the smaller the area of visual field seen through the magnifier. More words in a sentence can be viewed through a +10D magnifier than through a +20D magnifier. The power of the magnifier prescribed should be the maximum power which enables the child to perform the task required, but not above requirements, so that maximum visual field is maintained. Moving the eye closer to the lens of a hand-held or stand magnifier also increases the field of view. In West Africa, 71% of magnifiers prescribed were low power magnifiers (under +25D).[4] These were prescribed more frequently for those with a visual acuity of 3/60 or better. High power magnifiers (over +25D) were prescribed in 29% of cases, and were mainly prescribed for those with a visual acuity of less than 3/60.

To determine the appropriate ***type*** of magnifier, it is important to assess the child's personality, co-ordination, motivation and task aims. The same magnification can be provided using different mounting systems and working distances. Optical devices for near vision include: hand-held magnifiers (illuminated or non-illuminated); stand magnifiers (illuminated or non-illuminated); spectacle mounted magnifiers (e.g., high plus spectacle lenses, hyperocular lenses); and spectacle mounted telescopic units. The most widely available optical low vision devices for near vision are non-illuminated hand-held magnifiers, non-illuminated stand magnifiers, and high plus spectacle lenses. Advantages and disadvantages of these three types of magnifier are indicated in Table 1.

There are many benefits in providing magnifiers to children with low vision. The magnifiers encourage children to use their low vision to the full, thereby increasing visual stimulus and helping the children's development. The magnifiers promote literacy by increasing access to printed material for educational purposes and private reading. It is also more cost effective to provide children with optical devices enabling them to use standard books, than to provide large print books which are expensive and heavy to carry.

There are some limitations in providing magnifiers. Using a

Table 1: Practical Differences Between Magnifiers

	Hand-Held Magnifiers	Stand Magnifiers	High Plus Spectacle Lenses
Uses	• reading • looking at pictures • writing • identifying money • inspecting small objects	• reading • looking at pictures	• reading • writing • looking at pictures • close range
Advantages	• easy to carry around • available from low to • medium power • inexpensive to make • or high power • can be used at any position or angle	• has a fixed, stable • working distance • easy to use • available in low, medium,	• range of magnification • both hands free • readily available
Disadvantages	• difficult to keep • appropriate distance • one hand occupied • difficult to hold steady	• one hand occupied • not useful for writing • bulky to carry around • need flat working surface	• exact reading distance • important • heavy to wear

Aphakic spectacle corrections after congenital cataract surgery for two Romanian children

Photo: Clare Gilbert

magnifier may make a child's visual disability more noticeable, causing the child to feel different from other children. The human and financial resources available to provide the magnifiers may be limited. The child needs to be taught carefully how to use the magnifier, as the restricted field of view can prevent a child from perceiving the overall pattern of words, or sentences, on a page.

Supply of Magnifiers

Low power magnifiers can be made easily, using locally available materials. An optical workshop in Nairobi, Kenya developed a design using mounts made from plastic drain-pipe tubing. These are now used world-wide, as they are inexpensive (approx. $6 each) and robust. Hand-held and stand magnifiers can be made in a range of powers, from +8D to +28D. Instructions for making these are available from CBM International, Nibelungenstrasse 124, D-64625 Bensheim, Germany. Higher power magnifiers can be imported from Combined Optical Industries Limited (COIL), UK or Eschenbach, Germany. These are made from lightweight, plastic aspheric lenses, and cost between $6 (low power hand-held magnifier) and $34 (high power stand magnifier). They range in power from +8D to +76D.

Case Studies

In West Africa, 291 students with low vision were identified at eye clinics, special schools for the visually impaired, integration programmes and CBR programmes during 1995/6. All received an initial visual assessment, including distance and near visual acuity measurement, refraction, magnification assessment and a quantitative measure of their level of functional vision. The functional vision tests included orientation, activities of daily life, ability to recognise pictures and reading speed. A follow-up assessment was received by 139 students. At first assessment, 44% (128/291) of the students showed an increase in distance or near visual acuity with an optical device. Potential to read normal print (N10 or better), with or without the help of spectacles and/or a magnifier, was shown by 55% (159/291) of students. Those who benefited were provided with optical devices, and all the children with low vision received non-optical low vision devices and educational support. At follow-up assessment six months later, 63% (88/139) of students with low vision showed a further improvement in their distance visual acuity, near visual acuity and/or their functional vision. In special schools for the visually impaired in Ghana, 46% of students with low vision showed an improvement in reading and/or writing at their follow-up assessment.

These figures indicate that correctly prescribed optical devices can be of significant benefit to the child with low vision and, therefore, the provision of optical services should be an integral part of any low vision service.

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First published in *Community Eye Health* Vol. 11 No. 27 1998; pp. 38–40.

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Appendix: Selected Useful Resources

PUBLICATIONS

- **Standard List of Medicines, Equipment, Instrument, Optical Supplies and Educational Resources,** International Centre for Eye Health (address below), 34pp, free to eye health workers in developing countries. Electronic copies available free also on www.iceh.org.uk

- **Ophthalmic Operating Theatre Practice: A Manual for Developing Countries.** (Ingrid Cox and Sue Stevens), 2003, International Centre for Eye Health. Cost: £10.00 plus *post and packing*.

- ***Community Eye Health Journal***: Quarterly publication produced by the International Centre for Eye Health in English. French and Chinese editions and an Indian edition, with local supplement, are also available. Paper copies are available free to eye health workers in developing countries. On-line edition is available at www.jceh.co.uk and annual updates are available free on CD-ROM.

For further details of these and other ICEH publications, please contact:
Sue Stevens, International Centre for Eye Health, LSHTM, Keppel Street,
London WC1E 7HT;
Tel: 00 44 20 7958 8168;
E-mail: sue.stevens@Lshtm.ac.uk; Website: www.iceh.org.uk or www.jceh.co.uk (Community Eye Health Journal)

- ***Scan Optics Instrument Manuals***

Available at www.scanoptics.com.au/pdf/manuals.
32 Stirling Street, Thebarton, Adelaide
SA 5031 Australia   E-mail: info@scanoptics.co.au

- ***Care and Maintenance of Ophthalmic Equipment and Instruments***

A comprehensive resource by the Aravind Eye Hospital to be made available in video and DVD formats. Please contact Prof V Srinivasan at
1 Anna Nagar, Madurai 620 020,
Tamil Nadu India.
Tel. +91 452 2532653 /856100;
Fax: 91 452 253 0984;
E-mail: courses@aravind.org
Website: www.aravind.org

INFORMATION ON INSTRUMENT MAINTENANCE SHORT COURSES

- **India:** Aravind Eye Hospital run regular short courses. Contact: Prof V Srinivasan at the address given in the previous column.

- **Nigeria:** The National Eye Centre run courses on an ad-hoc basis depending on demand. Contact: Engr. Kayode Davis,
Chief Instrument Engineer, National Eye Centre (NEC), Off Nnamdi Azikiwe Way,
P.M.B. 2267, Kaduna State, Nigeria.
Fax: 234 -062-215642;
Telephone: 234-062-315026;
e-mail: nec_instrument@yahoo.co.uk
(note underscore after nec)

- **East Africa:** A training course is planned but not yet in place.

Note: An updated list of **community eye health-related courses** is published in **IAPB News** (published quarterly), available from: International Agency for the Prevention of Blindness Central Office, L.V. Prasad Eye Institute,
L.V. Prasad Marg, Banjara Hills, Hyderabad
500 034, India.
Tel: +91-40-2354 5389
Fax: +91-40-2354 8271.
Email: iapb@lvpei.org.
Website: www.iapb.org

WEBSITES

- **VISION 2020: The Right to Sight**: www.v2020.org (official website of the VISION 2020 global programme).

- **VISION 2020 E-Resource:** www.laico.org/v2020resource/homepage.htm (developed by Aravind Eye Care, the website is an excellent source of on-line resources on hospital management and community eye health publications)

- International Centre for Eye Health: www.iceh.org.uk (with additional educational resources available free on-line).

- Low Vision Resource Centre: www.hksb.org.uk

These websites contain links to other useful resources.