

Corneal blindness

Prevention, treatment and rehabilitation



Matthew J Burton

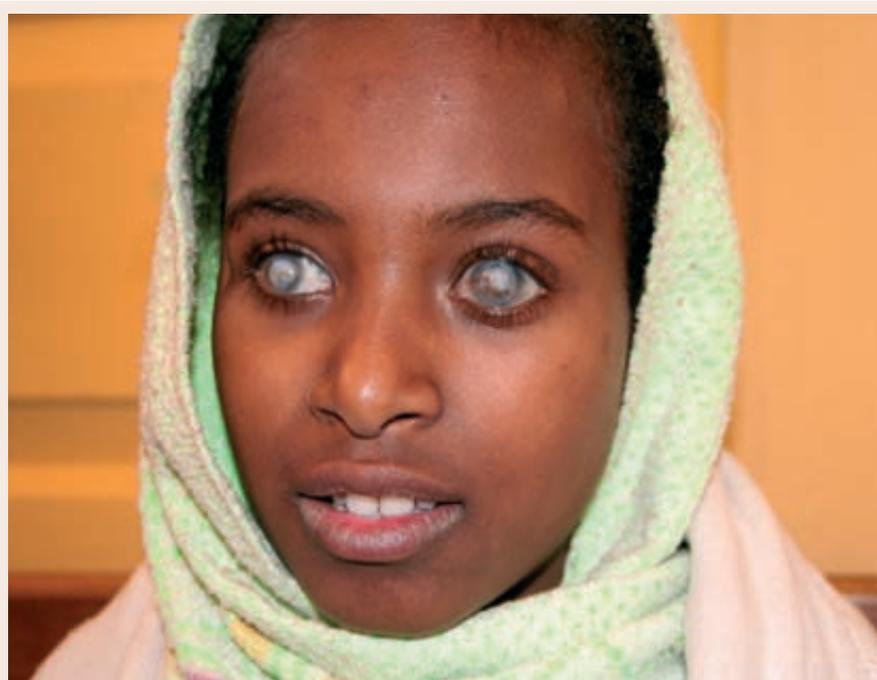
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The patient

Mr Massae (not his real name) is a forty-eight year old farmer who recently presented at a tertiary ophthalmology unit in Tanzania with a three-week long history of pain, purulent discharge, and loss of vision in the left eye. Several days after the onset, he had received treatment from his local health centre (chloroamphenicol drops), but his eye continued to get worse. At presentation, he had a large corneal ulcer with infiltration and a hypopyon. A filamentous fungus was cultured from microbiology specimens. He was treated with intensive topical antifungal (econazole) and anti-bacterial (ciprofloxacin) drops, a topical cycloplegic (atropine), and an oral antifungal medication (itraconazole). A small corneal perforation developed which plugged with iris and then sealed. The infection gradually responded to prolonged antifungal therapy, leaving a dense scar and small eccentric pupil (Figure 1, over page). Four years earlier, Mr Massae had lost sight in his right eye due to severe suppurative keratitis following a minor corneal abrasion from a maize leaf; this caused dense scarring of his right cornea (Figure 2, over page). Mr Massae is now blind.

The burden

Unfortunately, Mr Massae's story is not unique. Blindness from corneal disease is a major ophthalmic public health problem.



Lance Beilers

Corneal blindness often affects people at a young age, such as this twelve year old girl who is blind from vitamin A deficiency. She has had a penetrating corneal graft in her left eye; this has unfortunately failed. ETHIOPIA

According to the most recent WHO global data on the causes of blindness (2002), 'corneal opacities' affected 1.9 million people (5.1% of the total number of blind people). If other conditions causing blindness through corneal pathology are included, such as trachoma, vitamin A deficiency, ophthalmia neonatorum, and onchocerciasis, the number would be significantly higher. Moreover, there are probably many tens of millions more who are blind in one eye from corneal disease.

The burden of corneal blindness on the individual and the wider community can be huge, particularly as it tends to affect people at a younger age than other blinding conditions such as cataract and glaucoma. It also disproportionately affects poor rural communities, because of the increased risk of eye injuries from contaminated objects such as plant material, limited access to treatment, and higher prevalence of communicable diseases such as trachoma

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and onchocerciasis. Mr Massae illustrates the burden from corneal disease: he is currently unable to farm his land and provide food for his family.

The causes

There are many different conditions which can damage the structure and shape of the cornea leading to visual impairment and blindness. These include infectious, nutritional, inflammatory, inherited, iatrogenic (doctor-caused), and degenerative conditions (see box opposite). Disease patterns vary in different environments. Overall, in low- and middle-income countries, infectious keratitis tends to be the most common problem. However, other conditions, such as trachoma or onchocerciasis, may dominate in some areas.

Controlling corneal blindness

There are three important elements to addressing corneal blindness: prevention, treatment, and rehabilitation. In this issue of the *Community Eye Health Journal*, you will find articles addressing aspects of each of these. In Mr Massae's case, we can see how all three elements are needed, as well as some of the challenges in their implementation.

Prevention

Some blinding corneal conditions are very difficult to treat once established; however, they can be prevented by specific public health interventions (see page 36).

- **Xerophthalmia**, which is caused by vitamin A deficiency and sometimes precipitated by measles, accounts for more than half the new cases of childhood blindness each year. In addition to blindness, these young children are at increased risk of death. Prevention is key: vitamin A supplementation, measles vaccination, and nutritional advice have led to a marked reduction in this condition.
- **Trachoma**, caused by recurrent infection with *Chlamydia trachomatis*, causes blinding corneal opacification through the

traumatic effect of entropion/trichiasis and possibly secondary bacterial infection. Once established, trachomatous corneal opacification is difficult to treat: the results of corneal grafting are often disappointing, in part due to a dry and damaged ocular surface. Blinding trachoma can be prevented through the full implementation of the SAFE Strategy (Surgery for trichiasis, Antibiotics for infection, Facial cleanliness and Environmental improvement to control transmission).

- **Onchocerciasis (river blindness)** leads to blindness through an inflammatory response to the microfilaria of *Onchocerca volvulus* in the retina and the cornea. Control programmes have been very effective in preventing blindness through the mass distribution of ivermectin and measures to control the *Simulium* fly.
- **Traumatic corneal abrasion** is a common event and is the major risk factor for microbial keratitis in low- and middle-income countries. Simple topical antibiotic prophylaxis for a few days while the epithelium heals can protect the eye from developing potentially blinding infection. Mr Massae lost the sight in his right eye after

'The results of corneal grafting after blinding trachoma can be disappointing'



Jamshyd Masud/Sightsavers

Trachoma is one of the most common causes of corneal blindness. Improvement in water supply facilitates facial cleanliness, one of the four components of the SAFE strategy for trachoma control. PAKISTAN

Figure 1. Mr Massae's left eye, after several weeks of treatment

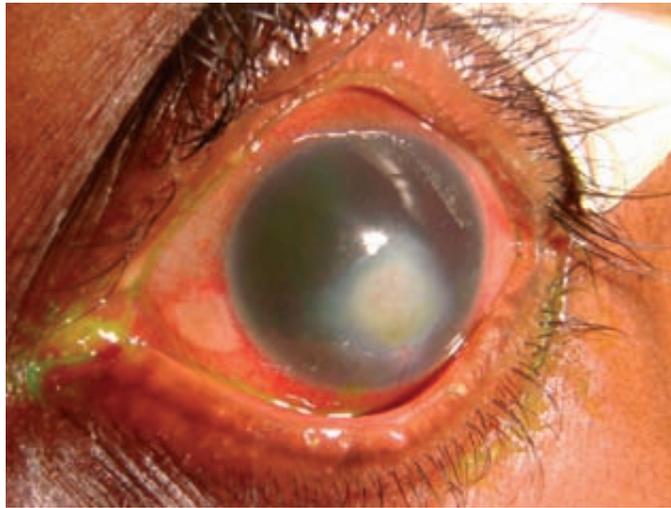
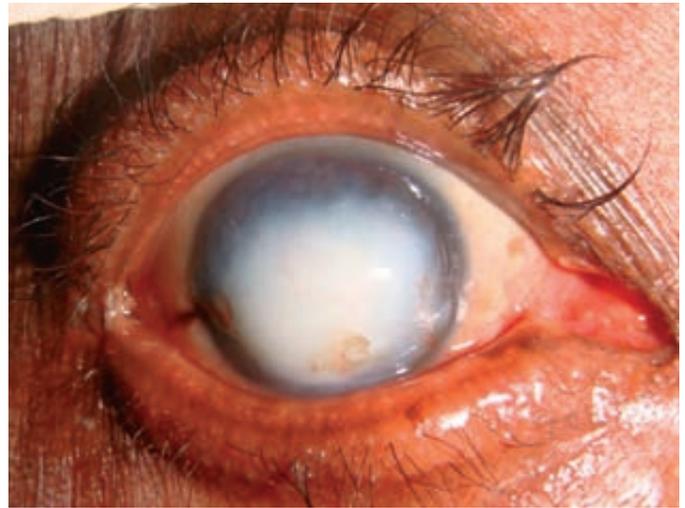


Figure 2. Mr Massae's right eye



Matthew Burton

Matthew Burton

an abrasion caused by vegetable matter. It is possible that early antibiotic prophylaxis could have prevented this.

Treatment

In most low- and middle-income countries, microbial keratitis is the most common acute blinding corneal problem requiring treatment. There is often a history of minor trauma. If appropriate antibiotic prophylaxis is not started soon after the injury, infection can become established. In temperate climates, most infections are bacterial. In contrast, in tropical regions, fungal keratitis is more frequent and may account for about half the cases.

The treatment of microbial keratitis is discussed in detail in the articles on pages 39–41.

Several problems make it difficult to deliver effective treatment for microbial keratitis in a low- and middle-income country setting. These problems need to be addressed by eye care programmes in order to reduce the risk of blindness from microbial keratitis and include:

- **Delayed presentation.** There may be many days or even weeks between the onset of symptoms and the presentation of the patient at an appropriate health facility. This delay is often catastrophic, allowing time for deep-seated infection to develop and extensive corneal damage to occur. Timely presentation may be promoted through health education and training of staff at primary health facilities to recognise and refer patients with established microbial keratitis.
- **Traditional medication.** This may sometimes be used by the patient before presentation and can make the problem more severe through the harmful effect of toxic compounds and infection with additional microorganisms.
- **Microbiology.** It may not be possible to obtain a microbiological diagnosis or information about the sensitivity of the organism. This can lead to the use of ineffective treatment and is particularly a

problem when fungal keratitis is missed. The development of a basic microbiological service with gram staining of slides can help to identify some cases of fungal infection. Blindness control programmes need to know which organisms commonly cause microbial keratitis in their population as well as their pattern of antibiotic resistance so that appropriate drugs can be supplied to health facilities.

- **Inadequate treatment.** The patient may not receive effective treatment. This can occur for several reasons: appropriate antibacterial or antifungal drops may not be available, the microorganism may be resistant to the medication, or the drops may not be given with sufficient intensity. Some of these problems can be overcome with the development of locally appropriate treatment protocols.

Mr Massae's case illustrates some of these issues. It was several weeks before he reached an ophthalmology unit and received treatment, which contributed to the severity of the case. It was very helpful in his management to have a microbiological diagnosis as it guided the choice and duration of treatment.

Rehabilitation

Mr Massae is now blind. However, his left eye has perception of light and has the potential to see better; to be rehabilitated. It may be possible to offer him some improvement in vision with a pupilloplasty. In addition, as the left corneal scar does not involve the superior cornea, a rotational auto-graft, in which an eccentric corneal button is cut and rotated to bring the clear superior cornea into the centre, may help. However, a penetrating corneal graft (transplant) would probably offer him the best quality of vision.

In many low- and middle-income countries, options for visual rehabilitation from corneal disease are limited as it usually requires the services of an ophthalmologist with sub-specialty training in corneal surgery, equipped to perform the

surgery and with access to donated corneas from an eye bank.

In this issue, there is an article on corneal grafting (page 44) which discusses the indications for corneal grafting, the outcomes for different conditions, and some of the potential complications. The following article focuses on eye banking (page 46) and addresses some of the specific challenges involved in running an eye bank service and finding donors.

Without rehabilitation services, Mr Massae and several million people like him are destined to a life without sight. Without the implementation of the public health and treatment interventions outlined above, many more will be at risk of joining them.

Causes of corneal blindness

Infectious

- Bacterial keratitis
- Fungal keratitis
- Viral keratitis
- Trachoma
- Onchocerciasis
- Leprosy
- Ophthalmia neonatorum

Nutritional

- Vitamin A deficiency (xerophthalmia)

Inflammatory

- Mooren's ulcer
- Steven's Johnson Syndrome

Inherited

- Corneal stromal dystrophies
- Fuch's endothelial dystrophy

Degenerative

- Keratoconus

Trauma

- Corneal abrasion predisposing to microbial keratitis
- Penetrating trauma
- Chemical injury

Doctor-caused (iatrogenic)

- Pseudophakic bullous keratopathy



Preventing corneal blindness: working with communities



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Preventing corneal blindness in the community involves action by the community itself, as well as actions by government and non-governmental organisations in the form of health and development services. In order to be effective, eye health workers need to understand how all of the above can work together.

Prevention of corneal blindness takes place at three levels:

- 1 Primary prevention:** Actions or interventions taken to prevent the onset of disease
- 2 Secondary prevention:** Actions taken to prevent complications and/or the development of visual disability due to an existing disease
- 3 Tertiary prevention:** After the immediate problem has been addressed by surgery or other treatment, actions to restore function or reduce existing disability from disease complications, i.e. corneal transplantation (see page 44).

Right up to the point when someone is seen by an eye care worker or admitted to hospital, the community will influence what happens.

Consider ophthalmia neonatorum as an example. As an eye care worker, you may have little control over the following:

- **the risk factors and immediate medical causes**, e.g. parents' sexual behaviour and the presence of *Neisseria gonorrhoea*
- **the contributory and social factors**, e.g. the lack of antibiotic drops in the labour ward, poverty associated with



Traditional remedies, such as the one around this boy's neck, contribute to delays in seeking medical treatment. THE GAMBIA



Lance Beilers/Sightsavers International

Community development projects help to reduce the most common causes of corneal blindness. TANZANIA

dangerous work, poor access to water and sanitation, or a community's preference for traditional medicines.

However, the community has the potential to influence most of these factors, either through change in the behaviour of individuals, or by lobbying for improvements at the community level.

The eye care worker's role, in particular when designing or participating in programmes to reduce corneal blindness, should be to inform and assist the community to address whichever of the above factors are relevant. This will allow the community to become an active partner in the prevention of corneal blindness.

First steps

A successful corneal blindness prevention programme **does not:**

- focus solely on individual diseases
- ignore the perceptions, knowledge, and abilities of the community
- work in isolation from other services in the health system.

A successful corneal blindness prevention programme **does:**

- address the overall causes of corneal blindness in the community
- aim to understand the community, build on their existing knowledge, and encourage and support them to campaign for better services
- understand the health and development services available in the community with a view to supporting them and making the best possible use of them.

Whether you are planning to improve a prevention programme or designing a new one, it is helpful to learn as much as possible about what the community needs and how they may be able to support your programme.

Doing so ensures that as many people as possible are involved right from the start.

It is a good idea to do a situation analysis, which will help to clarify what you know about the community and identify any gaps in your knowledge (which you will then need to fill).

Here are some questions to get you started:

- What are the community's knowledge and perceptions regarding the causes and treatment of corneal blindness?
- What are the existing and traditional methods of communication within the community? How can these be used to transmit new health messages?
- How will the community's knowledge and perceptions influence the content of health messages and how they are presented?
- What skills exist within the community that may be used to support the programme?
- What are the first points of contact for care: homes, schools, traditional healers, or pharmacists/chemist shops? What first aid is usually practiced?

Primary prevention

Primary prevention of corneal blindness is particularly relevant for the following causes:

- vitamin A deficiency and measles
- ophthalmia neonatorum
- trachoma
- eye injuries.

There are many social factors associated with corneal disease, such as poverty, inadequate water supply and sanitation, poor nutrition, and dangerous agricultural practices. Other contributing factors may include the high cost or unavailability of medicines or safety goggles. A good programme should support the community to obtain the health care and other services it needs, either by mobilising the community's own resources or by lobbying government for help.

To address the immediate medical causes and risk factors, the programme should provide health education about risk factors and how to avoid them, as well as information about what to do and where to go for help if an eye problem develops.

Support for these activities may be possible by closely collaborating with the health promotion unit of the local or national health system.

Good communication is essential. Use what you have learnt from the situation analysis to plan communication activities, for example by using existing and community-friendly methods. In urban areas, use the media and billboards. In rural areas, a meeting of the village elders may be more effective. Integration of eye health messages into the school curriculum is another possibility.

Secondary prevention

The cornea is transparent and sensitive to pain. As a result, patients with corneal disease or injuries are usually in pain and may suffer from photophobia; their eyes may water and they may have blurred vision. These all prompt the patient or carer (in the case of a child) to take action early.

Because of the pain, people may self-medicate, either with harmful medicines obtained from family members or from nearby care providers such as traditional healers or local pharmacists/chemist shops.

These early attempts at seeking care may be harmful, but also delay the process of obtaining correct treatment from the nearest medical facility. Both factors – wrong management and delay – may contribute more to corneal opacity and visual loss than the original cause.

Fighting corneal blindness by strengthening health systems

Understanding the health systems which already serve the community will help to ensure that new programmes make the best use of what is available and don't overload existing services. With careful thought, it may even be possible for a programme to contribute to the existing health systems, leaving them stronger and better able to serve the community in future.

Many health and community development programmes already in existence, such as measles immunisation, perinatal care, nutrition, water supply, and sanitation, make a significant contribution to reducing the most common causes of corneal blindness. It is important to support these programmes by informing policy makers and funding agencies of their impact on the prevention of blindness, as this will increase the motivation of those involved and may improve the prospects for

continued political and financial support.

The following aspects of existing health systems can be strengthened with your help.

'A good programme should support the community to obtain the health and other services it needs'

The health work force

- Work with the community to identify individuals who can provide home-based care and training. These could include retired professional people such as health workers or teachers who have returned to live in their communities. Support them either directly or through existing primary health care structures.
- Collaborate with existing health workers, traditional or not. For example, ensure that they are aware of the dangers of steroid eye drops and that they understand why it is important to instil antibiotic or antiseptic drops in newborn babies' eyes.
- Teach all health workers to diagnose and refer corneal pathology early.

Medical products and vaccines

- Ensure that basic items, such as torches and antibiotic/antiseptic drops, are available at points of need, e.g. in labour

wards, with traditional birth attendants, or in schools.

- Support existing efforts to provide vaccines and ensure cold chains.

Health information

- Gather information about the impact of corneal disease and trauma in the community. For example, ensure that ophthalmia neonatorum is a notifiable disease and record the number of children with measles or xerophthalmia.
- Gather evidence about the effectiveness of community-focused intervention measures, such as water and sanitation programmes, immunisation campaigns, or free health care for children.
- Use your evidence to improve programme design and service delivery, and to lobby the authorities to maintain and strengthen these programmes.

Health financing

- Work with the community to ensure that emergency eye care for corneal infections or trauma, particularly in children, is free and that cost does not restrict access to treatment.

Leadership and governance

- Work with the decision-making bodies responsible for the local community's development and health. Encourage them to allocate resources to measures such as latrine construction and home-based care.
- Encourage communities to take the lead on health matters, for example by working with community development groups. Ordinary people can take responsibility for a range of interventions, from household-led health activities such as face washing to demanding better services.
- Support and encourage communication between the community and decision makers within the health system, as well as between different groups or specialties in the health system.

Conclusion

As an eye health worker designing or implementing a programme to prevent corneal blindness in the community, you should understand both the medical causes of corneal scarring, and the non-medical and social factors that lead to corneal blindness. You should recognise the potential of the community to be involved and actively seek out ways to ensure their involvement.

It is vital to understand the impact of development programmes led by other government departments (education, agriculture, water resources, community development, and justice) on the prevention of corneal blindness. Eye workers must support and work with these initiatives.

In order to do this well, you, as an eye health worker, should develop non-medical skills such as communication, negotiation, advocacy, and the ability to foster community engagement.



Eye health posters used to inform the community. THE GAMBIA

Eyelid control during an eye examination



Sue Stevens

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Before performing any eye procedure

- **Wash your hands** (and afterwards too)
- **Position the patient comfortably** with head supported
- **Avoid distraction** for yourself and the patient
- Ensure **good lighting**
- Always **explain to the patient** (and any companion, if appropriate) what you are going to do.

Reasons for eyelid control during eye examination

- to provide a good view of the eyeball for the examiner
- to avoid unnecessary discomfort for the patient

Remember!

It is important to be very gentle at all times, in particular when an injured, painful, or postoperative eye is being examined. To do otherwise may cause further problems. Eyelid control is very important!

Preparation

Position the patient comfortably. Depending on the circumstances, this may be:

- lying down with his or her head on a pillow
- sitting down with his or her head resting against a wall or headrest, or with the head supported by the hands of an assistant (Figure 1)
- sitting down at a slit lamp with head supported on the chin rest.

Method

- Ask the patient to **look up** and hold this gaze
- With the index finger, **gently and slowly** pull down the lower eyelid

This position will enable a good view of the lower eyelid margin and lower eyeball (Figure 2).

- When examination of this area is complete, **gently and slowly** remove the index

finger and allow the patient to close the eyes for a few seconds

- Ask the patient to **look down** and to hold this gaze
- With the tip of the thumb, **gently and slowly** touch the top eyelid midway between the eyelid margin and the eyebrow (Figure 3) – **do not exert any pressure!**
- Ease the eyelid up, **gently and slowly**, against the bony orbital rim

This position will enable a good view of the upper eyelid margin and the upper eyeball (Figure 4).

- When examination of this area is complete, **gently and slowly** remove the thumb and allow the patient to close the eyes
- Tell the patient when the examination has ended.

IMPORTANT! These principles should be followed **every time** and by **every examiner**.



Figure 1

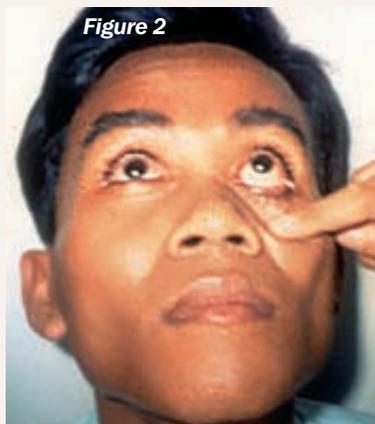


Figure 2



Figure 3



Figure 4

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USEFUL RESOURCES

Useful resources: corneal blindness

Community Eye Health Journal

Kanyi S. Evaluation of the impact of Nyateros (friends of the eye) in the delivery of eye care services after one year of its implementation in Lower River division, The Gambia. *Community Eye Health J* 2005;18(56): 130–134.

Lecuona K. Assessing and managing eye injuries. *Community Eye Health J* 2005;18(55): 101–104.

Garg P, Rao GN. Corneal ulcer: diagnosis and management. *Comm Eye Health J* 1999;12(30): 21–23.

Baba I. The red eye: first aid at the primary level. *Community Eye Health J* 2005;18(53): 70–72.

Books

Eye diseases in hot climates. By John Sandford-Smith. £12 from TALC.

Hanyane: a village struggles for eye health. By Erica Sutter, Victoria Francis, and Allen Foster. Free to download from www.cehjournal.org/icehpubs.asp or £5 from TALC.

Other resources

A laboratory manual and guide to management of microbial keratitis. By Astrid K Leck, Melville M Matheson, and J Heritage. Free to download from www.cehjournal.org/icehpubs.asp

The red eye (poster). Free to download from www.cehjournal.org/icehpubs.asp or order from TALC.

Guidelines for the management of corneal ulcer at primary, secondary, and tertiary care in the Southeast Asia Region. Go to

www.searo.who.int/LinkFiles/Publications_Final_Guidelines.pdf

European Eye Banking Association. Visit www.europeaneyebanks.org or write to: European Eye Bank Association, Via Paccagnella n. 11, Padiglione Rama, 30174 Zelarino, Venice, Italy. Email: admin@europeaneyebanks.org

Supplier: TALC

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Managing corneal disease: focus on suppurative keratitis



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Introduction

Infections of the cornea can lead to corneal opacity and blindness if not identified quickly and managed appropriately. The terms infective keratitis, suppurative keratitis, and microbial keratitis are all used to describe suppurative infections of the cornea. These are characterised by the presence of white or yellowish infiltrates in the corneal stroma, with or without an overlying corneal epithelial defect, and associated with signs of inflammation (Figure 1).

The common symptomatic complaints of patients with suppurative keratitis are as follows (all with varying degrees of severity):

- redness of the eye
- circum-corneal congestion (typically)
- pain
- blurring of vision
- photophobia
- watering of the eye.

The aim of this article is to review both bacterial and fungal keratitis, with an emphasis on identification and management at the primary, secondary, and tertiary levels. Guidelines for referral will be suggested.

Figure 1. A severe bacterial ulcer caused by *Pseudomonas* sp. The gram negative (-ve) bacillus can cause complete destruction of the cornea within a few days. This cornea is at risk of perforation.



Dr M Srinivasan/Aravind Eye Hospital

Fist steps in management

History taking

History taking is an important step in management of corneal infection. If there has been an injury, ask when and where the injury was sustained, what the patient was doing at the time of injury, whether or not he or she sought help following the injury, and what treatment – including traditional eye medications – may have been used.

A past history of conjunctivitis may suggest that the infection is secondary to a conjunctival pathogen.

Examination

1. Visual acuity

Visual acuity should always be recorded in all cooperative patients. If it is not possible to record the visual acuity of a child, for example, a note of this should be made. Vision should be recorded first in the unaffected eye, then in the affected eye; with or without glasses. This provides a useful guide regarding the prognosis and response to treatment. It is also important documentation in the event of medico-legal issues.

2. Examination of the cornea

A torch with a good source of focused light and a loupe for magnification are essential. A slit lamp microscope, if available, is always helpful, but not absolutely essential.

Another essential tool is fluorescein dye, either in a sterile strip or a sterile solution. Fluorescein stains any part of the cornea that has lost the epithelium, even due to a trivial injury, and appears brilliant green when viewed under blue light (Figure 3).

3. Corneal scrape

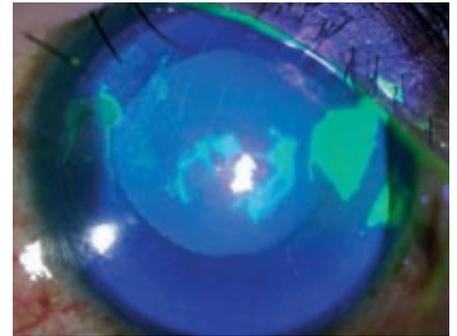
Diagnosis should be confirmed by obtaining a corneal scraping from the corneal lesion and subjecting it to laboratory testing at secondary or tertiary eye care facilities. See article on page 42.

Figure 2. A bacterial ulcer. The eye is very red and inflamed. Note the ring infiltrate in the cornea and a large hypopyon in the anterior chamber.



Dr M Srinivasan/Aravind Eye Hospital

Figure 3. Fluorescein staining



Management at primary level

A suppurative corneal ulcer is an ophthalmic emergency which should be referred to the nearest eye centre for proper management. The following are useful guidelines when referring the patient to the secondary eye care centre.

- **Do** apply antibiotic drops or ointment
- **Do** instruct patients and/or their accompanying persons to apply drops frequently until patients arrive at the centre
- **Do** instruct patients and/or their accompanying persons to avoid traditional medicines.
- **Do not** give systemic antibiotics; they are not helpful
- **Do not** use steroid drops and/or ointment; they can be dangerous
- **Do not** routinely patch the eye; it is not necessary.

Management at secondary level

More complete management of corneal infections begins at the secondary level of eye care where there is an ophthalmologist and/or an ophthalmic assistant, or a physician trained in managing common eye diseases. At the secondary level:

- A corneal scraping should be taken (see page 42).
- The patient should be admitted to the hospital to ensure adequate treatment and frequent follow-up.

Specific initial treatment

No fungal elements seen

- instil cefazolin 5% and gentamicin 1.4% drops hourly.
- Ciprofloxacin or ofloxacin is a good substitute for gentamicin and cefazolin. If it is not possible to administer hourly drops, a subconjunctival injection can be given.

Continues overleaf ►

Fungal elements seen

- Natamycin 5% drops hourly or freshly reconstituted amphotericin-B 0.15% as drops hourly. Antibiotics may have a limited role to play in such cases and may occasionally be harmful. Clinical judgment correlated with laboratory tests constitute the best guide in such cases.

Adjunctive treatment

- Atropine 1% or homatropine 2% could be used twice a day to dilate the pupil; this helps to prevent synechiae and relieve pain
- Oral analgesics will help to minimise pain
- Anti-glaucoma medication may be advisable if the intraocular pressure is high
- Vitamin A supplementation may be helpful, particularly in countries where Vitamin A deficiency is markedly prevalent.

Five A's are a useful acronym to remember: **A**ntibiotic/antifungal, **A**tropine, **A**nalgesics, **A**nti-glaucoma medications, and **V**itamin **A**.

Subsequent management

Suppurative keratitis patients should be hospitalised and examined daily, if possible with a slit lamp, so that their response to treatment can be evaluated and the frequency of antibiotics adjusted accordingly.

Reduce the frequency of antibiotic administration when the patient experiences symptomatic improvement (less tearing and photophobia, relief from pain, and improvement in vision) and when the ulcer shows signs of improvement:

- decrease in lid oedema
- decrease in conjunctival chemosis and bulbar conjunctival injection
- reduction in density of the infiltrate and area of epithelial ulceration
- haziness of the perimeter of the ulcer and of the stromal infiltrate
- decrease in inflammation; cells, fibrin, and level of hypopyon
- dilatation of pupil.

In the case of bacterial infection, the inflammatory reaction may be enhanced by endotoxin release during the first 48 hours of treatment; however, definite progression at this stage is unusual and implies that either the organisms are resistant to therapy, or the patient is not instilling the drops as prescribed.¹ If the patient is judged to be improving, the dose of antibiotics and/or antifungal drops should be reduced from hourly, to two-hourly, then four-hourly over the next two weeks in case of bacterial ulcers. For fungal ulcers, treatment should be continued with three-hourly drops for at least three weeks.

Guidelines for referral to a tertiary centre

Immediate referral on **presentation** if:

- the ulcer is in an only eye
- the patient is a child
- there is impending or actual perforation

- a fungal corneal ulcer is suspected but KOH or other fungal stains are not available.

Following initial treatment: if cases of bacterial ulcer fail to show any improvement within three days, and fungal ulcers within a week, patients should be referred to a tertiary care centre.

Management of corneal ulcer at tertiary level

Many tertiary eye care centers have their own protocol for the management of corneal ulcer. The management suggested is based on a WHO recommendation for suitable modification according to circumstances.²

History, examination, and recording of findings

By the time patients have reached a tertiary centre, they will have travelled from one place to another with attendant hassles, received several treatments, may have lost faith in eye care personnel, and may already have run out of money, particularly in low-income countries. Attending to this situation is critically important in the overall care of corneal ulcer patients.

A careful history of the development of the disease may point to the existence of an underlying predisposing condition such as diabetes mellitus, immunosuppression due to local or systemic steroids (or other immunosuppressants), dacryocystitis, or other ocular conditions. A full list of drugs used by the patient should be obtained to ensure that drugs which have not helped in the past are not repeated; this may also help to discover possible drug allergies. Findings should be carefully noted on a standard form.

A meticulous corneal scraping subjected to laboratory processing often provides a sound guideline to treatment. See page 42.



Figure 3. Subtotal fungal ulcer

Dr. Whitcher/UCSF

Hospitalisation

This provides patients with rest and adequate medication; they can also receive frequent follow-up, management of systemic problems such as diabetes, and further surgical intervention, if warranted.

Treatment

The initial treatment depends on the results of the corneal scrape and the local pattern of pathogens and antibiotic resistance.

- If microscopy is negative, or it is not possible to perform a corneal scrape, or Gram-positive or Gram-negative bacteria are visualised, treat the patient with antibiotic eyedrops. Use either a combination of cefazolin 5% and gentamycin 1.4%, or fluoroquinolone monotherapy (eg. ciprofloxacin 0.3% or ofloxacin 0.3%). Drops should be given hourly to begin with for two days and then tapered, based on response.
- If microscopy reveals fungal hyphae, topical natamycin 5%, econazole 1% or amphotericin-B 0.15% should be used hourly for a week and then tapered.
- If the ulcer seems to respond well to treatment, continue therapy as before for two weeks for a bacterial ulcer and three weeks or more for fungal ulcer.
- If the response is poor and the culture shows growth of an organism, the choice of antibiotic is guided by the sensitivity reports.

Table 1. Preparation of fortified antibiotic eye drops

Antibiotic	Method	Final concentration
Cefazolin/cefuroxime	Add 10 ml sterile water to 500 mg cefazolin powder; mix and use as topical drops. Shelf life: 5 days	50 mg/ml (5%)
Gentamicin (tobramycin)	Add 2 ml parenteral gentamicin (40 mg/ml) to a 5 ml bottle of commercial ophthalmic gentamicin (3 mg/ml)	14 mg/ml (1.4%)
Penicillin G	Add 10 ml of artificial tears to a 1 million unit vial of Penicillin G powder; mix, remove, and place into empty artificial tear bottle or xylocaine vials (30 ml)	100,000 units/ml
Vancomycin	Add 10 ml sterile water to a 500 mg vial of vancomycin powder; mix, add sterile cap, and use	50 mg/ml (5%)
Amikacin	Add 2 ml of parenteral amikacin containing 200 mg to 8 ml artificial tears or sterile water in a sterile empty vial.	20 mg/ml (2%)

Table 2. Commonly recommended antifungal drugs

Drug	Topical	Systemic
Amphotericin-B	0.15–0.5% drops	IV infusion
Natamycin	5% drops	Not available
Econazole	2% drops	Not available
Voriconazole	1% drops	Oral tablets 100–200 mg/day
Ketoconazole	2% drops	Oral tablets 200–600 mg/day
Miconazole	1–2% drops	Intravenous injection
Clotrimazole	1–2% ointment	Not available
Fluconazole	0.2–0.3% drops	Oral tablets 200 mg/day

Although a large number of antifungal drugs are available for systemic mycoses, only few are effective for treatment of corneal ulcers. The commonly recommended drugs are given in Table 2.

However, except for natamycin and fluconazole, others are not available commercially for topical ocular use. The other antifungals have to be prepared using commercially available injectable forms such as amphotericin-B, miconazole, or raw materials such as clotrimazole and voriconazole.

Other agents such as polyhexamethylene biguanide (PHMB) 0.02%, chlorhexidine 0.02%, povidone iodine 1.5 to 5% and silver sulfadiazine 1% have been reported to possess variable antifungal activity and may be used if other drugs are not available.

Natamycin 5% suspension is recommended for treatment of most cases of filamentous fungal keratitis, particularly those caused by *Fusarium* sp. Topical miconazole 1% (not commercially available for topical use) can be used as adjunct or supportive therapy. Most clinical and experimental evidence suggests that topical amphotericin-B (0.15 to 0.5%) is the most efficacious agent available to treat yeast keratitis. Amphotericin-B is also recommended for fungal keratitis caused by *Aspergillus* sp. Oral ketoconazole (200–600 mg/day) may be considered as an adjunctive therapy in more severe fungal keratitis due to filamentous fungus. Oral fluconazole (200–400 mg per day) has been used successfully for severe keratitis caused by yeasts. Oral itraconazole (200 mg/day) has broad-spectrum activity against all *Aspergillus* sp. and *Candida* but has variable activity against *Fusarium* sp.

Fungal infection of the deep corneal stroma may not respond to topical antifungal therapy because of poor penetration of these agents in the presence of an intact epithelium. It has been reported that a 5 mm epithelial debridement (as a diagnostic scraping or therapeutic procedure) greatly enhances the penetration of antifungal drugs.

Animal experiments indicate that frequent topical application (every five minutes) for an hour can readily achieve therapeutic level.

Surgical management

The range of surgical interventions available for management of corneal ulcer may include debridement, corneal biopsy, tissue adhesives, conjunctival flap, tarsorrhaphy, or therapeutic corneal graft. Evisceration of the eye is performed for severe pain, panophthalmitis, or life-threatening complications.

Tarsorrhaphy

This is an old surgical technique that is still very useful today. In suppurative keratitis due to fungal and bacterial infections, tarsorrhaphy is effective in promoting healing, provided the ulcer has been sterilised by effective antibacterial and/or antifungal treatment. Following central tarsorrhaphy, it can be difficult to instil drops and to see the cornea, so it is vital to ensure that the infection is under control before closing the eyelids. However, tarsorrhaphy often leads to rapid resolution of persistent epithelial defects, whatever the underlying cause. Once tarsorrhaphy is performed it is left in place for at least one to three months. There are different surgical techniques which are described well in many standard ophthalmic text books; however, simply suturing the lids together with a non-absorbable stitch can be effective.

Conjunctival flap

The principle of this technique is to promote healing of a corneal lesion by providing adequate nutrition through the conjunctival blood vessels. The flap could be three types:

- 1 A total flap covering the entire cornea, called Gunderson's flap.
- 2 A pedicle (racquet) flap. A pedicle flap carries its own blood supply from the limbus and is useful for ulcers near the limbus.
- 3 A bucket handle flap. This carries its blood supply from both ends of the flap and may be less likely to retract. It is more useful for central corneal ulcers.

This procedure can be performed under local anaesthesia. Harvesting adequate bulbar conjunctiva in eyes which have had

previous surgery may be difficult. The flap should be as thin as possible, with minimal adherent subconjunctival tissue. Following removal of any remaining corneal epithelium, the flap should be sutured to the cornea with 10-0 nylon sutures.

The conjunctival flap promotes healing by vascularisation. It is particularly useful in patients with impending perforation, when it may preserve the globe and allow subsequent corneal grafting. However, a flap may limit the penetration of topical antibiotics, so it should only be performed once the ulcer has been sterilised and the infection brought under control.

Conclusion

Management of suppurative keratitis remains a major challenge worldwide, more so in low- and middle-income countries with inadequate health care resources. Although the outcome of treatment has improved significantly, many patients continue to deteriorate in spite of the best treatment that can be offered. The continued emergence of strains of microorganisms that are resistant to an ever-expanding range of antimicrobials poses an additional challenge. Further research related to prevention of suppurative keratitis and enhancing host resistance are two worthwhile goals to pursue. Large-scale public education programmes to sensitise those at risk of suppurative keratitis, and to encourage earlier presentation, should be undertaken. Coupled with this, education of practitioners, general physicians, and other health workers, as well as general ophthalmologists, will go a long way towards ensuring correct diagnosis, appropriate treatment, and timely referral before extensive damage to the cornea occurs. Management of corneal abrasions at primary care levels within 48 hours has been demonstrated by various studies to be the best way to prevent corneal ulcers in low- and middle-income countries.³⁻⁶ This could be adopted in any population and is cost effective both for health providers and the patient.

References

- 1 Allan BD, Dart JK. Strategies for the management of microbial keratitis. *Br J Ophthalmol* 1995;79: 777–786.
- 2 Guidelines for the management of corneal ulcer at primary, secondary and tertiary health care facilities. World Health Organization, South East Asia Regional Office, 2004.
- 3 Upadhyay M, Karmacharya S, Koirala S, et al. The Bhaktapur Eye Study: Ocular trauma and antibiotic prophylaxis for the prevention of corneal ulceration in Nepal. *Br J Ophthalmol* 2001;85: 388–92.
- 4 Srinivasan S, Upadhyay MP, Priyadarisni B, Mahalakshmi, John P Whitcher. Corneal ulceration in south-east Asia III: prevention of fungal keratitis at the village level in South India using topical antibiotics. *Br J Ophthalmol* 2006;90: 1472–1475.
- 5 Getshen K, Srinivasan M, Upadhyay MP, et al. Corneal ulceration in south-east Asia I: a model for the prevention of bacterial ulcers at the village level in rural Bhutan. *Br J Ophthalmol* 2006;90: 276–78.
- 6 Maung N, Thant CC, Srinivasan M et al, Upadhyay M, Whitcher J. Corneal ulceration in south-east Asia II: a strategy for prevention of fungal keratitis at the village level in Myanmar. *Br J Ophthalmol* 2006;90: 968–70.



Taking a corneal scrape and making a diagnosis



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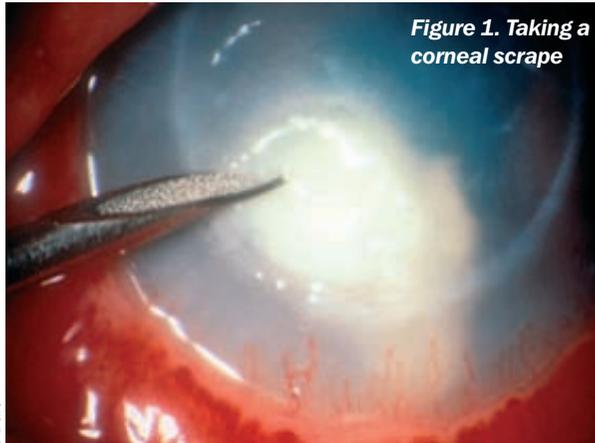
This article aims to provide a comprehensive guide to taking a corneal scrape and making a diagnosis. However, there are settings in which there are either limited or no laboratory facilities available to the ophthalmologist; for example, at primary level eye care centres in rural locations. In these circumstances, microscopy may still provide valuable information to guide the clinician in their choice of treatment (Figures 5–11 are images of infected corneal tissue as seen by microscopy).

Taking a corneal scrape

What you will need:

- **21-gauge needles or Kimura scalpel**
- **2x clean microscope slides**
- **1x blood agar plate (FBA)**
- **1x Sabouraud glucose agar plate (SGA)**
- **1x brain heart infusion broth (BHI) (for fastidious organisms)**
- 1x cooked meat broth (CMB) (excludes facultative anaerobes)
- 1x thioglycollate broth (TB)
- 1x non-nutrient agar (NNA) (if *Acanthamoeba sp.* is suspected)

In order to have the best possible chance of providing the clinician with an accurate diagnosis, all the media listed are required. In some remote settings, some media may not be available or there may be limitations in the variety of media it is possible to process. For these situations, the minimum requirements are denoted above in **bold type**, in order of importance. Liquid phase media (broths) must be used when available. If only one liquid phase media is



to be used, this should be BHI; it is essential to inoculate more than one bottle. NNA is indicated only if amoebic infection is suspected.

General principles

- If possible, withdraw the use of antimicrobial agents for 24 hours prior to sampling. Where this is not possible, the use of liquid phase media, for example BHI, serves as a diluent that reduces the concentration of the drug below the minimum inhibitory concentration (MIC).
- Apply anaesthetic drops that do not contain preservative.
- Use a different needle to take each specimen or, if using a Kimura scalpel, flame the scalpel between samples.
- If fungal or amoebic infection is suspected, it is preferable to sample material from the deeper stromal layer of the cornea.

Order of specimen preparation:

- 1 Slide for Gram stain and slide for alternative staining processes
- 2 Solid phase media (FBA/HBA, SGA, NNA)
- 3 Liquid phase media (BHI, CMB, TB)

If the ulcer is very discrete or only a small amount of corneal material is available, inoculate one solid and one liquid phase medium.

Specimen collection for microscopy

- Label slide with patient's name, date of birth, and hospital number.
- Draw/etch a circle on the slide and place specimen within the circle (Figure 2).
- Air-dry and cover with a protective slide (tape the ends) or place in a slide transport box.

Inoculating culture media

- Gently smear material on the surface of agar in C-streaks (Figure 3); taking care not to puncture the surface of the agar.
- Sellotape the lid of the plate to

the base around the perimeter.

- Incubate inoculated culture media as soon as possible. Refrigeration of specimens is to be discouraged and, if not being transported directly to the laboratory, it is preferable to keep samples at room temperature.

Making a diagnosis

Microscopy: the Gram stain

- 1 Air-dry and heat-fix specimen using a Bunsen burner or spirit lamp
- 2 Allow slide to cool on staining rack
- 3 Flood slide with crystal violet; leave for 1 minute (Figure 4)
- 4 Rinse slide in clean running water
- 5 Flood slide with Gram's iodine; leave for 1 minute
- 6 Rinse slide in clean running water
- 7 Apply acetone and rinse immediately under running water (exposure to acetone <2 seconds)
- 8 Counter-stain with carbol fuchsin for 30 seconds
- 9 Rinse in clean running water then dry with blotting paper
- 10 View specimen with 10x objective
- 11 Place a drop of immersion oil on the slide and view with 100x oil-immersion objective.

Figure 2. Slide with label and circle for placing the specimen

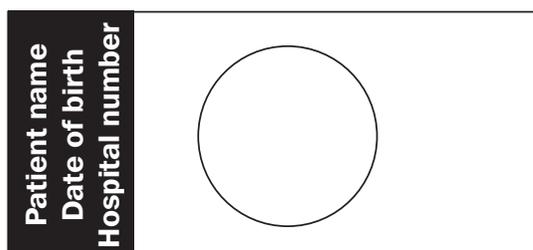
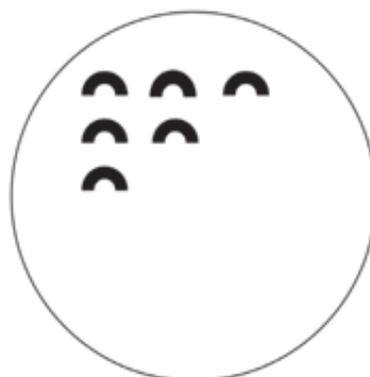


Figure 3. Smear the material on the surface of agar in C-streaks



Astrid Leck

Figure 4. Flood the slide with crystal violet



- Gram positive (+ve) cocci most commonly associated with suppurative keratitis are the *Staphylococci* (Figure 5) and *Streptococci* (Figure 6, *Streptococcus pneumoniae*).
- Gram negative (-ve) bacilli, such as *Pseudomonas sp.* (Figure 7), may be associated with corneal infection.
- A definitive diagnosis of *Nocardia sp.* (Gram variable) may be possible
- Yeast cells will stain positively.

Although not the first choice of stains for fungi, yeast cells, pseudohyphae, and fungal hyphae may be visualised in Gram-stained corneal material, typically staining negatively or Gram variable. For microscopy to provide a more definitive diagnostic tool for fungal infection, Gram stain can be destained and restained using a more appropriate stain (Figures 8 and 9).

Microscopy: additional methods

Lactophenol cotton blue (LPCB) or potassium hydroxide (KOH) wet mount preparations are used to visualise fungi (Figure 10).

- 1 Add a drop of lactophenol cotton blue mountant to the slide.
- 2 Holding the coverslip between your forefinger and thumb, touch one edge of the drop of mountant with the coverslip edge, the lower it gently, avoiding air bubbles. The preparation is now ready.
- 3 Initial observation should be made using the low power objective (10x), switching to the higher power (40x) objective for a more detailed examination.
- 4 Calcofluor white and Periodic Acid Schiff reaction (PAS) staining may also be used.

Diagnostic criteria

Diagnostic criteria applied to bacterial culture

- the same organism growing at the site of inoculation on two or more solid phase cultures, or
- growth at site of inoculation on one solid phase media of an organism consistent with microscopy, or
- confluent growth on one media.

Figure 5. Staphylococci sp.

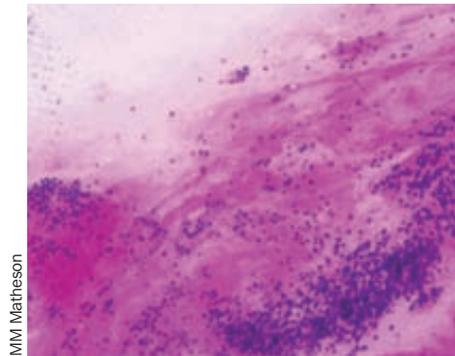


Figure 7. Pseudomonas sp.

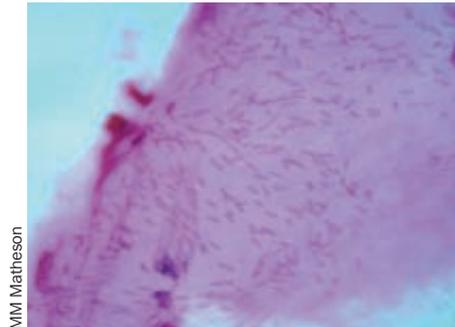


Figure 9. Fungal hyphae visible after Gram stain

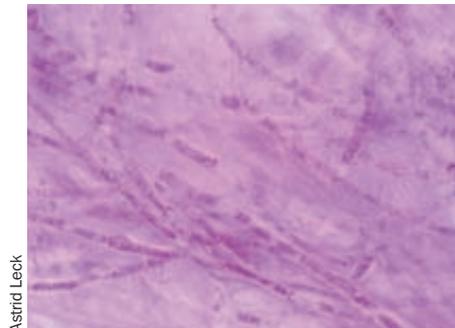
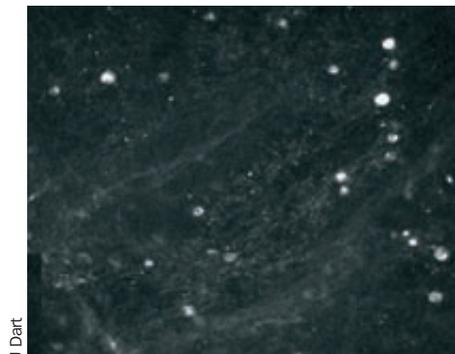


Figure 11. Calcofluor white preparation



Diagnostic criteria applied to fungal specimens

- fungal hyphae observed in corneal specimen stained on microscopic examination, or
- growth at site of inoculation on solid culture media

Amoebic infections

The cyst form of *Acanthamoeba sp.* can be visualised in corneal material using a direct fluorescent technique such as calcofluor white (Figure 11), haematoxylin

Figure 6. Streptococcus pneumoniae

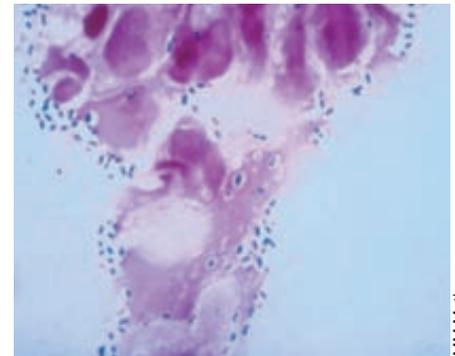


Figure 8. Gram appearance of yeast cells (left) and pseudohyphae (right)

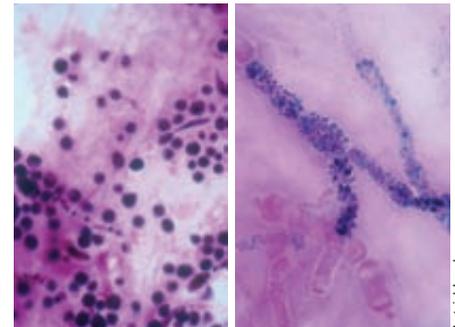


Figure 10. Fungal hyphae stained with lactophenol cotton blue

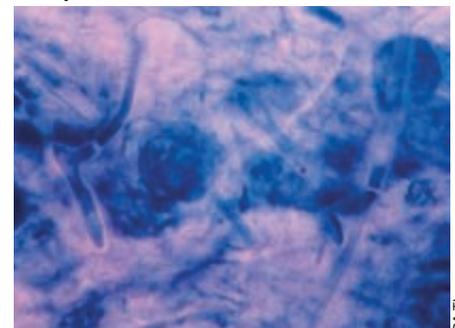
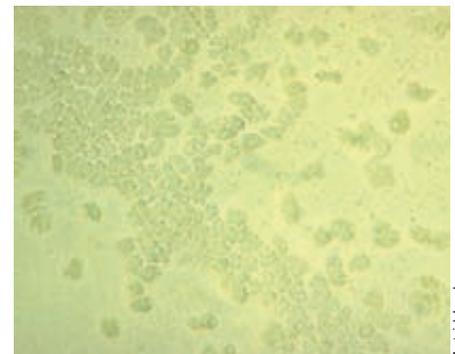
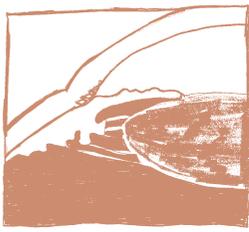


Figure 12. The trophozoite form of Acanthamoeba



and eosin, LPCB, or PAS. If corneal infection with *Acanthamoeba sp.* is suspected, inoculate corneal material onto non-nutrient agar in a demarcated area of the plate. In the laboratory, the square of agar where the specimen was inoculated will be excised and inverted onto an NNA plate seeded with a lawn of *E. coli*. Growth of the trophozoite form is imperative to confirm viability of the organism and thus prove it to be the organism responsible for infection (Figure 12).



Corneal grafting: what eye care workers need to know



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Introduction

We know that many of the most common causes of corneal blindness: vitamin A deficiency, trachoma, and ophthalmia neonatorum, can be prevented by simple primary health care measures. Some conditions are more difficult to prevent, but can be effectively treated, such as suppurative keratitis (page 39) or herpes simplex keratitis. However, some patients will still develop blinding corneal disease. What can be done for them?

At present, the best hope for curing corneal blindness is a corneal transplant, also known as a corneal graft.

In contrast with most other transplants, corneal grafting is relatively straightforward. Although additional surgical training is needed, the operation itself requires little equipment beyond a standard cataract set and a good operating microscope. Because there are no blood vessels in the cornea, the likelihood of rejection is less than for other transplants.

In this article, we want to provide guidance to eye care workers who want to know who should be referred for a graft and what complications they may need to manage after patients have had their operation.

What is corneal grafting?

In this operation, the central 7–8 mm of the patient's own diseased cornea is removed. A similar-sized disc of donor cornea is then inserted and sutured into position. In most cases, the full thickness of the cornea, including epithelium, stroma, and endothelium, is transplanted; this is known as a penetrating graft. However, it is also possible to trans-

Figure 1. Keratoconus. Note the central scarring, with thinning and ectasia



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Table 1. Indications for corneal graft and their prognoses

Diagnosis	Prognosis
Keratoconus	Excellent
Corneal dystrophies, such as lattice, granular, Fuch's	Excellent
Corneal scar – healed ulcer	Moderate
Bullous keratopathy – aphakic or pseudophakic	Moderate
Herpes simplex keratitis	Moderate
Corneal scar: active ulcer/keratitis, threatened perforation (grafting may be done to salvage the eye, rather than vision)	Poor
Corneal scar: trachoma	Very poor
Ocular surface disorder: chemical burn, Stevens-Johnson syndrome	Very poor
Mooren's ulcer	Very poor
Re-graft	Very poor

plant just the outer, anterior layers (stroma and epithelium) or the inner, posterior layers (endothelium and Descemet's membrane).

Indications and prognoses

Any corneal disorder that causes visual impairment may be an indication for a corneal graft. However, the prognosis for corneal grafting varies greatly.

The risk of rejection is higher if the cornea is vascularised (contains blood vessels), or is inflamed or perforated (as is liable to occur in severe suppurative keratitis, for example). The same holds true for any eye that has generalised disease of the ocular surface.

Table 1 lists some of the different diagnoses that may be treated by a corneal graft, along with their prognoses. Conditions with a "very poor" prognosis should not be treated by corneal grafting as this is a waste of valuable transplant tissue.

The visual prognosis for a corneal graft is also affected by the state of the rest of the eye, not just the cornea and ocular surface. Uncontrolled intraocular pressure (IOP) is a contraindication to grafting, as IOP control is likely to be worsened by a corneal graft. Patients with known posterior segment disease affecting the retina or optic nerve are also unlikely to benefit.

A corneal graft requires much more postoperative care than a cataract extraction. This entails repeated clinic visits and using expensive eye drops frequently; therefore, the patient must value their new cornea and be motivated to take care of it.

Patients are most likely to value their new cornea if the grafted eye is their better eye. In general, this means that patients with unilateral disease and perfect vision in the other eye are poor candidates. There are exceptions: for example, if the eye is painful

as well as visually impaired.

Corneal grafting in children has a very poor prognosis and requires more intense postoperative care; it should therefore be considered carefully.

Outcomes

Studies from South India¹ showed that 69 per cent of grafted corneas were clear at two years after surgery. In East Africa,² 87 per cent of grafts for keratoconus survived for at least two years, compared to 65 per cent performed for other diagnoses.

Unfortunately, a clear graft does not guarantee good vision. Patients may have coexisting problems, such as glaucoma, cataract, or amblyopia. Because corneal grafting alters the shape of the cornea, it often causes significant astigmatism, which can be difficult to correct with spectacles.

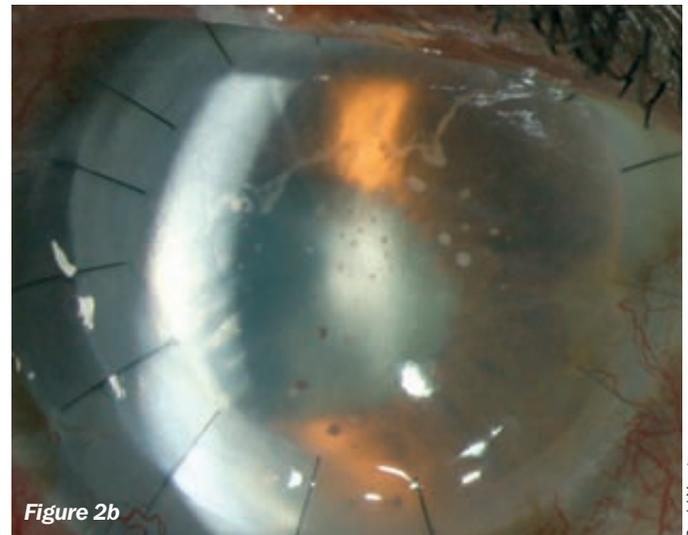
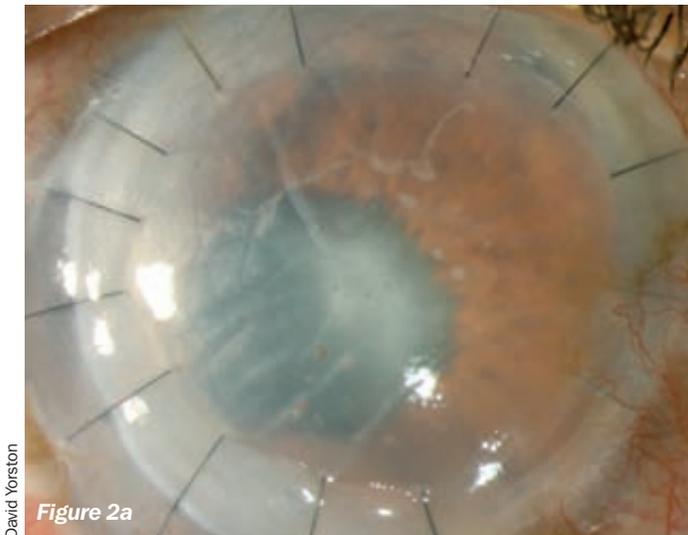
Visual outcomes in East Africa² were much better for patients with keratoconus than for those with other diagnoses. In patients grafted for keratoconus, 33 per cent were <6/60 in both eyes preoperatively, compared to 5 per cent post-operatively; 78 per cent could see 6/18 or better following surgery. This data showed that corneal grafting is an effective cure for blindness caused by keratoconus.

This also demonstrates the importance of monitoring and reporting the outcomes of corneal graft operations.

Complications

The main causes of graft failure in both South India¹ and East Africa² were graft rejection and infectious keratitis. Both of these complications are treatable and often preventable. In many cases, graft failure could have been prevented by early and effective management at a local eye clinic.

Figure 2. Graft rejection. Note oedema in the lower two-thirds of the graft (Figure 2a) along with multiple keratic precipitates (Figure 2b)



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Rejection

Graft rejection is caused by an immune reaction directed against the foreign endothelial cells of the transplanted cornea. Approximately 20–30 per cent of penetrating grafts will have a rejection episode at some time. The most common symptoms of graft rejection are blurred vision, light sensitivity, redness, and pain; patients should be advised to attend an eye clinic immediately if they develop any of these symptoms. Rejection is recognised by the appearance of corneal oedema in a previously clear graft. The oedema usually spreads upwards across the graft from the inferior edge of the transplanted cornea. The eye is often inflamed and a line of keratic precipitates may be seen at the edge of the oedematous cornea.

Preventing rejection begins with selection for surgery. Some diagnoses, such as keratoconus and other corneal dystrophies, have a very low risk of rejection. Following surgery, rejection is prevented by topical steroid drops. These are used at different frequencies for varying lengths of time, depending on the underlying diagnosis and the perceived risk of rejection. Whatever steroid regime is used, the drops should never be suddenly stopped, but should always be tailed off gradually. The usual duration of steroid therapy following a full thickness graft is six months in phakic patients and twelve months in pseudo-phakic or aphakic patients.

With prompt diagnosis and immediate treatment, graft rejection can often be reversed. The recommended **management of graft rejection** is intensive steroid treatment, initially in the form of hourly topical steroid drops. The use of systemic steroids, such as 500 mg methylprednisolone, has been shown to make little difference to the outcome and the authors therefore do not recommend it.

Infection

The second common cause of graft failure is suppurative keratitis. This presents in the same way as any other microbial keratitis

(page 39). Patients with corneal grafts are at increased risk of corneal infection because they have reduced corneal sensation and are often on long-term topical steroids. The management of infectious keratitis is the same in these patients as it is for anyone else. A scraping should be taken for gram stain and culture if available (see page 42). Intensive antibiotic treatment, either monotherapy with a topical fluoroquinolone (such as ofloxacin) or combination treatment with a cephalosporin (such as cefuroxime) and an aminoglycoside (such as gentamicin) is started immediately after the scraping has been taken, and is continued for at least 48 hours. In some settings, anti-fungal treatment may be required.

Loose suture

The most common predisposing factor for infectious keratitis following a corneal graft is a loose suture. With time, as the graft wound heals, the very fine sutures either break or become loose. In both cases, they will erode through the corneal epithelium. This destroys the barrier effect of the epithelium and allows microorganisms to get into the cornea where they cause infection. A loose suture also promotes the growth of blood vessels into the cornea, which can lead to rejection.

Figure 3. A broken stitch has caused blood vessels to grow into the corneal graft, increasing the risk of rejection. It is surrounded by infiltrate, which may indicate infection



David Yorston

All loose or broken sutures which protrude through the epithelium should be removed immediately. They can be detected by staining the cornea with fluorescein. Eye workers are sometimes reluctant to remove a corneal suture for fear that it may be the only thing holding the cornea together! This is an understandable reaction; however, if the stitch is loose or broken, then it cannot be providing any support to the wound. It is not serving any useful purpose and greatly increases the risk of complications, and it should be removed urgently.

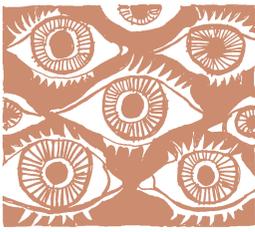
To remove the suture, give local anaesthetic drops three times and wait three to five minutes. Cut the suture with the sharp edge of a 26G needle. Using a pair of very fine forceps, grasp the end of the stitch and pull it gently out of the eye. Always give antibiotic drops for five days afterwards to prevent infection.

Summary

- Most corneal blindness can be prevented, but for those patients who have bilateral visual impairment caused by corneal disease, a corneal graft is the only hope of restoring sight.
- The best candidates for a corneal graft are patients with keratoconus or other corneal dystrophy, in whom about 90 per cent of grafts will remain clear for at least two years.
- Good postoperative care is essential. Patients must remain on topical steroids for a long time, and these should never be stopped suddenly.
- Graft rejection is often reversible if it is treated immediately with intensive topical steroids.
- All loose sutures should be removed immediately to reduce the risk of microbial keratitis.

References

- 1 Dandona L, Naduvilath TJ, Janarthanan M, Ragu K, Rao GN. Survival analysis and visual outcome in a large series of corneal transplants in India. *Br J Ophthalmol* 1997; 81: 726–31.
- 2 Yorston D, Wood M, Foster A. Penetrating keratoplasty in Africa: graft survival and visual outcome. *Br J Ophthalmol* 1996;80: 890–4.



Eye banking: an introduction



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While prevention is the most desirable way to control corneal blindness, once a cornea has lost its transparency, a corneal transplant, or graft, is a patient's best chance to regain vision in the affected eye(s). However, the biggest limiting factor is the worldwide shortage of donated corneas.

In low- and middle-income countries, where the magnitude of corneal blindness is greatest, the availability of donated corneas is very low. This is due in large part to the lack of local eye banks. Efforts are under way to develop eye banks of optimal standards in many low- and middle-income countries, with countries like India and Philippines making notable progress. Myanmar, Ethiopia (see box right), and Kenya are examples where high quality eye banks have been established. However, this is still not enough to meet the need for corneas.

What is an eye bank?

Eye banks are the institutions responsible for collecting (harvesting) and processing donor corneas, and for distributing them to trained corneal graft surgeons.¹ Eye banks are regulated and part of the local health system; they may be attached to a hospital or housed in a separate building.

Cornea harvesting is the surgical removal from a deceased person of either the whole eye (enucleation) or the cornea (in situ corneal excision). This can be done by appropriately trained eye care personnel (eye bank technicians, ophthalmology residents, ophthalmologists, or general practitioners) in a variety of settings, including hospitals, homes, and funeral grounds.

Before harvesting

Corneas can be harvested up to twelve hours after death, but ideally within six hours. The person who will harvest the cornea must first do the following:

- Obtain written consent from the senior next of kin of the deceased.
- Verify the death certificate and ensure there is a stated cause of death.
- Review the donor's medical and social history to ensure they have no contraindications to donation. (This is done by studying medical records, interviewing the physician under whose care the donor

was, and interviewing close family members. Each eye bank must have a list of such contraindications, which are available from other well-established eye banks.)

- Obtain information about any blood loss occurred prior to and at time of death, and whether the donor received infusion/transfusion of crystalloids, colloids, and blood; these are used to calculate plasma dilution.

During harvesting

Aseptic methods must be adhered to, including maintaining a sterile field while performing enucleation or in-situ corneal excision.² Standard protocols include:

- pen torch examination of the eyes for foreign objects and other defects
- preparing the face and eyes of the donor using povidone iodine
- employing aseptic techniques for in situ corneal excision or enucleation
- immediate preservation of the excised eye

or cornea in an appropriate cornea preservation medium

- drawing blood to screen the donor for infectious diseases. Each eye bank must decide the most appropriate serological tests needed but at a minimum they must test for HIV, hepatitis B, and syphilis.

Storing donated corneas

Whole eyes can be stored in a moist chamber at two to eight degrees Celsius. This is the simplest and least expensive way to store whole eyes, but the eyes have to be used within 48 hours. Such a storage method may be suitable for some eye banks with limited resources.

Excised corneas can be stored in intermediate-term preservation media, such as McCary Kaufman medium (MK medium) or Optisol, both maintained at four degrees Celsius. Corneas can be stored for 96 hours in the MK medium and ten days in Optisol.

With the availability of MK medium and

The Eye Bank of Ethiopia



A group of children on a visit to the Eye Bank of Ethiopia

The Eye Bank of Ethiopia in Addis Ababa has been in existence since 2003. It is associated with Menelik II Referral Hospital, a tertiary referral centre, where most of the transplants are done. The eye bank also sends corneas to two university referral hospitals in northwestern and southern Ethiopia. Between 130 and 150 corneas are harvested (using in situ corneal excision) and used in 90–120 transplants every year.

There are five corneal transplant surgeons in Ethiopia. Cornea donation is encouraged in a variety of ways, including media campaigns with well-known personalities such as the president of Ethiopia and athlete Haile Gabreselassi. So far, 6,000 Ethiopians, including Mr Gabreselassi, have pledged their corneas, and next-of-kin consent is being used increasingly. The eye bank is funded by ORBIS International Ethiopia and Addis Ababa City Government Health Bureau; it also raises funds locally. (Elmien Wolvaardt Ellison)



A technician at work in the Eye Bank of Ethiopia

Optisol, eye banks should ideally switch over from enucleation to in situ corneal excision procedures. This will enable better viability of donated corneas during storage. With increased resistance to the antibiotics used in preservation media, inclusion of alternative antibiotics must be considered.³

After corneas reach the eye bank, they are examined using a slit lamp to check for corneal and stromal pathology. The endothelial cell density is also examined by specular microscope; this is necessary as donor corneas with a low number of endothelial cells are likely to fail soon after surgery. The processing of whole eyes must be done within a laminar flow hood maintained in sterile conditions.

The suitability of a cornea for transplantation is assessed by the corneal surgeon, who will consider the donor screening report, slit lamp and specular microscopic results, and serology reports. Following processing and evaluation of corneas and serological testing, transplantable corneas are transported to hospitals individually sealed and packaged, maintaining the cold chain at four degrees Celsius. The vial containing the cornea must be labelled properly with the eye bank name, tissue number, name of the preservative medium, medium lot number, expiry date of the medium, and date and time of the donor's death. The surgeon must also be provided with the donor screening, tissue evaluation, and serology reports. It is important that the eye bank follows a fair and equitable system of tissue distribution.

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OBITUARY PROF BARRIE JONES

Dear Editor,

It was with great sadness that we learnt of the death of **Prof Barrie Jones** on 19 August 2009 in Tauranga, New Zealand, aged 88.

He was admired worldwide for his work in developing the concept of prevention of blindness and for establishing the International Centre for Eye Health (publishers of the *Community Eye Health Journal*) in 1981. He was in fact responsible for encouraging the launch of the first issues of this journal. However, your readers may not be aware of his major contributions, earlier in his career as first clinical professor of ophthalmology in the University of London, to the science and management of corneal and external eye disease.

Barrie first addressed the range of virus infections of the eye seen in London, writing about adenovirus infection and corneal involvement by the vaccinia virus. He conducted much laboratory research on herpes simplex infection, and randomised trials of interferon, idoxuridine, trifluorothymidine, adenine arabinoside, and ultimately acyclovir. A rational approach was developed to the management of different stages of herpetic keratitis, including mechanical debridement, when to use corticosteroids,

Standards

Eye banks should develop and adhere to acceptable standards. This reduces the risk that grafts will fail or that infection will be transmitted. It may help to refer to the technical guidelines and acceptable minimum medical standards of the European Eye Banking Association (see Useful Resources, page 38).

Finding donors

Even with an effective eye bank, finding enough people willing to donate their corneas can be difficult.

Public awareness programmes play an important role. They must emphasise that corneas can be donated by anyone, whatever their age, religion, or gender, and that neither enucleation nor in situ corneal excision causes disfigurement of the face or any delays in funeral arrangements. Family pledging is also becoming more important as family consent is usually needed before eyes or corneas can be removed.

Some of these problems may be circumvented by favourable legislation for eye donation, such as a 'required request' law. This law requires hospital authorities to identify potential cornea donors and obtain consent from bereaved family members. Another law employed in some countries, such as the United States and Ethiopia, is a 'presumed consent' law. Under this law, every person who dies while in hospital is presumed to be an eye donor unless this is actively rejected by their next of kin.



Ramayamma International Eye Bank, IVP

An eye donation counsellor speaks to family members of a deceased person. INDIA

Hospital cornea retrieval programmes can meet some of the immediate need. In these programmes, trained eye donation counsellors approach family members of the deceased and motivate them to consider eye donation. Training these counsellors in the art of grief counselling assists them in approaching family members at an appropriate time, sharing their grief, and preparing them to take the positive step of giving permission for eye donation on behalf of their loved one.

References

- 1 Rao GN. What is eye banking? *Indian J Ophthalmol* 1996;44: 1-2.
- 2 Mannis MJ, Reinhardt WJ. Medical standards for eye banks. In Brightbill F (ed): *Corneal surgery, theory, technique and tissue*, pp 531-548. St Louis: CV Mosby, 1993.
- 3 Gopinathan U, Agarwal V, Sharma S, Rao GN. Donor corneal scleral rim contamination by gentamicin resistant organisms. *Indian J Ophthalmol* 1994;42: 71-74.



Barrie Jones, after his retirement, discussing the progress of the clinical trial of ivermectin with Prof Adenike Abiose. NIGERIA

and the role of corneal grafting.¹

Although a much less common cause of keratitis than in tropical countries, fungi nonetheless caused serious corneal infections in London. Barrie and his colleagues cultivated and tested the sensitivity of every fungus isolate to many different potential new drugs. He emphasized that the variations in sensitivity within each species were so great that it was necessary to base rational therapy on the results of sensitivity testing of each patient's own fungus.²

Barrie Jones was widely known as an authority on many aspects of trachoma. He developed methods of isolation, culture, and laboratory diagnosis. In extensive field studies in Tunisia, Iraq, and Iran he eluci-

dated the seasonal dynamics of transmission of blinding hyperendemic trachoma, recognising the importance of multicyclic re-infection and the role of flies in transmission in these countries. He carried out trials of early potential vaccines and of chemotherapy.³

He investigated and wrote about an astonishing range of other corneal conditions, including infections by amoebae, vernal and other allergic types of keratoconjunctivitis, Thygeson's superficial punctate keratitis, pemphigoid, and dry eye syndromes. In the operating theatre, he pioneered new surgery of the lacrimal canaliculi and duct and improved the techniques, postoperative management, and outcomes of corneal grafting.

When, around 1980, he turned the full energy of his thinking to the questions of blindness prevention, it was informed by this rich background of laboratory and clinical experience.

Gordon Johnson

Recommended reading

- 1 Jones BR. Symposium on Herpes Simplex eye disease. *Trans Ophthalmol Soc UK* 1977: 97; 305 - 355
- 2 Jones BR. Principles in the management of oculomyiasis. XXXI Edward Jackson Memorial Lecture. *Am J Ophthalmol* 1975: 79; 719 - 751
- 3 Jones BR. The prevention of blindness from trachoma. The Bowman Lecture 1975. *Trans Ophthalmol Soc UK* 1975: 95; 16 - 33

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Community Eye Health Journal news

Last issue of 2009

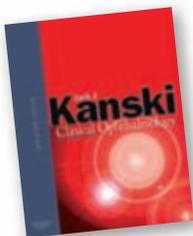
Due to budgetary constraints, we regret that this is the final issue of *The Community Eye Health Journal* in 2009, making a total of three rather than four issues. We hope that our funding situation will improve and that we will be able to resume our usual publication schedule in 2010. We also welcome donations from readers who would like to support the journal and keep it going: please visit www.cehjournal.org/donate to find out how you can help.



Digital video competition

We are launching an exciting new reader competition: we want to know what the *Community Eye Health Journal* means to you and how it has changed the way you work. Readers are invited to submit a short digital video clip showing how you use the journal: how it has improved your work, how patients have benefited, or how you use it to teach others. First prize is *Clinical*

Ophthalmology by J Kanski (kindly donated by Elsevier), worth £128. The winning clips will be published on the *Community Eye Health Journal* website and in the next edition of the journal update CD.



In order to qualify, send your digital video on CD or DVD, or upload it onto YouTube (www.youtube.com) and send us the link by email. Please use only video file formats accepted by YouTube and include your name, contact details, and a short description of the video in your package or email. **Deadline:** 1 August 2010.

Maximum length: Two minutes. **Patient permission:** If your video shows any patients,

you must get their written permission and include this in your entry. **Send to:** *The Community Eye Health Journal*, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK, or email editor@cehjournal.org More information: www.cehjournal.org/competition

Did you know?

The Access to Research Initiative (HINARI) provides not-for-profit institutions in low- and middle-income countries with free or very low cost access to biomedical and social science journals. All staff members and students at the qualifying institutions are entitled to access the journals. To learn more and register your institution, visit www.who.int/hinari/en

Meetings

World Ophthalmology Congress, Berlin, 5–9 June 2010. Visit www.woc2010.org

XXI Congress of the International Society Geographical and Epidemiological Ophthalmology (ISGEO), Berlin, 3–4 June 2010. Attendees must be registered for the World Ophthalmology Congress. Visit <https://www.iceh.org.uk/x/ngoq>

World Congress on Refractive Error, Durban, 20–22 September and **Sixth World Conference on Optometric Education**, Durban, 22–24 September 2010. Abstract submissions for both close 1 March 2010. Visit www.icee2010.co.za

Courses

International Centre for Eye Health, UK Application forms for all courses are available from The Registry, 50 Bedford Square, London WC1B 3DP, UK. Tel: +44 207 299 4646. For more information about all ICEH courses, email Elizabeth Mercer: elizabeth.mercer@Lshtm.ac.uk

MSc Community Eye Health, 27 September 2010 to 16 September 2011 (also available on a part-time basis over two years). Cost: UK £15,150 (overseas students) or UK £4,815 (home and EU students)

Diploma Course in Community Eye Health, 17 February to 21 May 2010. Cost: UK £7,040 (overseas students) or UK £2,156

(home and EU students)
Email: registry@Lshtm.ac.uk or MScCEH@Lshtm.ac.uk
or visit www.Lshtm.ac.uk/courses

Planning for VISION 2020, 12–16 July 2010. Cost: UK £735

Tropical ophthalmology, 29–31 March 2010. Cost: UK £490

Public health planning for hearing impairment, 12–16 July 2010. Cost: UK £750. Email: shortcourses@Lshtm.ac.uk or visit www.iceh.org.uk

Community Eye Health Institute, South Africa

All courses cost ZA R2,500 (approximately US \$350). Contact Aayesha Patel, Community Eye Health Institute, University of Cape Town, Private Bag 3, RONDEBOSCH, 7700, South Africa, Tel +27 21 406 6215. Email: aayesha.patel@uct.ac.za or visit www.cehi.uct.ac.za

Community eye health for ophthalmology registrars, 13–15 April
Training of trainers for primary eye care, 31 May to 4 June 2010 and 25–29 October 2010 (two courses)

Project management for Vision 2020, 26–30 July 2010

Monitoring and evaluation for Vision 2020, 23–27 August 2010

Leadership and management for Vision 2020, 20–23 September 2010

Kilimanjaro Centre for Community Ophthalmology, Tanzania

All courses paid for by various sponsors. Contact Genes Mng'anya, Good Samaritan Foundation, PO Box 2254, Moshi, Tanzania, Tel +255 27 275 3547. Email: genes@kcco.net or visit www.kcco.net

Gender and blindness: review of the evidence and identifying research needs, 11–13 March 2010

Working with management to get the support you need to achieve VISION 2020 goals: a course for ophthalmologists, 19–23 April 2010

Strengthening the capacity of national prevention of blindness coordinators, 10–14 May 2010

Addressing the challenges of childhood cataract in Africa, 20–23 September 2010 (Nigeria)

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Next issue

Lance Bellers/ICEH



The next issue of the *Community Eye Health Journal* will be on **children and eye care**