EXTENDED REPORT

Infective keratitis in older patients: a 4 year review, 1998–2002

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Br J Ophthalmol 2005;**89**:591–596. doi: 10.1136/bjo.2004.049072

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Accepted for publication 1 September 2004

Background/aim: There are few clinical series in the literature of infective keratitis in the elderly, even though this age group constitutes a significant proportion of those affected by this condition. The authors aimed to determine the incidence and risk factors for infective keratitis in those over 60 years, the causative organisms, antibiotic susceptibilities, visual and tectonic outcome, and surgical intervention rate.
Methods: A retrospective review of all patients aged 60 years and over admitted to the Sydney Eye Hospital with a diagnosis of infective keratitis, between September 1998 and December 2002.
Results: 190 patients were identified with a mean age of 75.5 (SD 9.6) years (range 60–101). Local risk factors were found in 93.7%, and systemic risk factors in 27.9%. Organisms were cultured in 62.8%, and 7.9% had positive herpes simplex virus (HSV) polymerase chain reaction (PCR). Perforation or severe thinning occurred in 36% overall, but in 80% with positive HSV PCR. Acute surgical intervention was required in 43.7%, with acute penetrating keratoplasty performed in 17.9%, and 8.9% required evisceration. Mean presenting visual acuity was 1.82 (SD 1.24), equivalent to 6/300, excluding 26.3% with vision of light perception (LP) or worse. Mean final visual acuity was 1.24 (SD 1.16), equivalent to 6/100, excluding 19.5% with vision of LP or worse ($p<0.0005$).
Conclusions: The elderly represent a distinct clinical group in the context of microbial keratitis. Predisposing factors are very common, they present with poor vision, have a high complication and surgical intervention rate, and a poor visual outcome compared to younger patients. The microbiological spectrum is similar to younger age groups, except that HSV is more common and may increase the risk of severe corneal thinning and perforation. Most bacterial isolates remain sensitive to currently available antibiotic preparations.

Infective keratitis is a significant cause of blindness and preventable ocular morbidity worldwide. There are many published series of infective keratitis from both temperate and tropical parts of the world, and management strategies are well established. However, infective keratitis continues to be an important cause of hospital admission, particularly among vulnerable patient groups such as the elderly. With increasing numbers of those of retirement age, the demands this group place on healthcare systems worldwide will continue to rise. Despite this, there are only two published studies of infective keratitis in the elderly population: the first from the United States,[1] a series from over 20 years ago, and more recently, one from rural southern India.[2]

The elderly represent a distinct clinical group in the context of microbial keratitis, as they are less likely to be contact lens wearers (except in aphakia) than younger patients, they are more likely to have had previous or co-existent ocular disease or surgery, and the visual prognosis is significantly worse in older patients.[2 3] Musch *et al*[4] showed a bimodal age distribution for infective keratitis with two distinct peaks of incidence, one around the age of 30, and another at 70 years.

The purpose of this study was to identify in those over 60 years, the risk factors for infective keratitis, the microbiological spectrum, and the visual and tectonic outcome, over a 4 year period at a single tertiary referral centre in south eastern Australia.

PATIENTS AND METHODS

All patients aged 60 years and over who were admitted to the Sydney Eye Hospital between September 1998 and December 2002 with a diagnosis of infective keratitis were included in the study. Cases were identified from the database of clinical codes, based on the primary and other diagnoses, recorded for each patient on discharge from the hospital.

Medical records were then retrieved and the data recorded on a standardised form. The data set included details of patients' age, sex, length of hospital admission, treatment before admission, identifiable local and systemic risk factors, pre-existing ocular disease, other medical history, clinical features, investigations performed, organisms identified, antibiotic sensitivities, treatment and duration of treatment, complications, acute and other surgical interventions, final diagnosis, presenting and final visual acuity, and length of follow up.

Visual acuity was documented in Snellen format, and converted into logMAR equivalent values for analysis. Presenting and final visual acuities were compared using two tailed, paired Student's *t* test. Those with visual acuity of light perception (LP) or worse were excluded from mean calculations, but stated separately, as these levels of visual acuity cannot be assigned geometric mean values.[5]

Corneal scrapes were routinely performed on admission with a flame sterilised Kimura spatula or a sterile scalpel blade, placing the specimen onto slides for Gram stain, and direct inoculation of culture media: horse blood agar for aerobic and anaerobic culture, chocolate agar, cooked meat broth, and Sabouraud's dextrose agar for fungi. If *Acanthamoeba* was suspected, non-nutrient agar seeded with *Escherichia coli* was also inoculated. In addition, if clinically indicated, patients were tested for herpes simplex virus

Abbreviations: CVA, cerebrovascular accident; DFA, direct fluorescent antibody; HSV, herpes simplex virus; HZO, herpes zoster ophthalmicus; LP, light perception; MIC, minimum inhibitory concentration; PCR, polymerase chain reaction; PK, penetrating keratoplasty

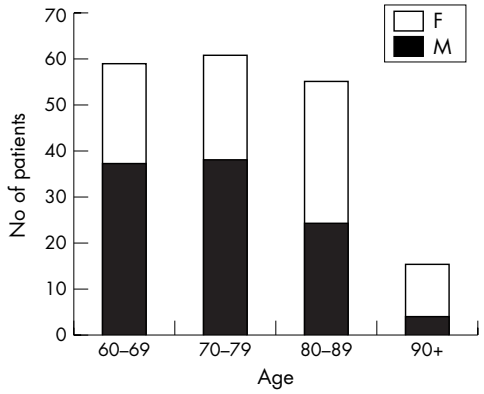

Figure 1 Patient age groups and sex distribution.

(HSV) using direct fluorescent antibody (DFA) assay, viral culture, or more recently polymerase chain reaction (PCR).[6] The media were sent to the South Eastern Area Laboratory Services (SEALS) at the Prince of Wales Hospital, Randwick, NSW, for culture and antibiotic susceptibility. All bacterial isolates were identified using conventional laboratory techniques and stored at −70°C. The minimum inhibitory concentration (MIC) of selected antibiotics was determined on each isolate using an agar dilution technique, which conformed to the recommendations of the International Collaborative Study on Antibiotic Sensitivity Testing.[7]

RESULTS

Over the 4 year study period we identified 190 patients for inclusion in the study. Medical records were available for all patients. There were 103 (54%) male and 87 (46%) female patients, with a mean age of 75.5 (SD 9.6) years (range 60–101). The age distribution is shown in figure 1, which shows that although, overall, males are slightly over-represented, beyond the age of 80 there is a female preponderance. The peak incidence occurred in the winter months of June–August, during which there were 73 (38%) admissions (fig 2). The mean length of hospital admission was 17.6 (SD 13.1) days.

Predisposing factors

At least one local risk factor was present in 178 (93.7%) patients (table 1), with more than one risk factor in 42 (22.1%). Previous ocular surgery was the most prevalent risk factor, occurring in 88 (46.3%) patients, but note the small numbers of patients with a history of trauma (3.7%), or contact lens wear (1.1%), as shown in table 1. Systemic risk factors were identified in 53 (27.9%) patients. These are summarised in table 2.

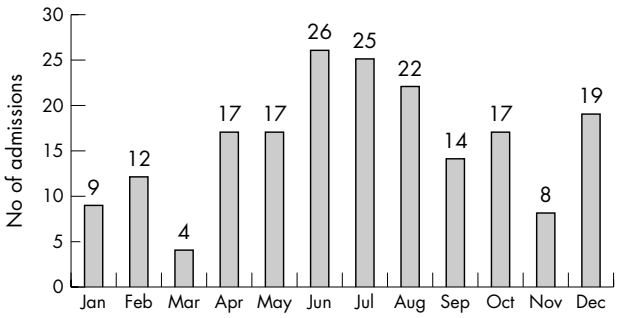

Figure 2 Seasonal variation of admissions.

Table 1 Identified pre-existing local risk factors

Risk factor	No	%
Previous ocular surgery	88	46.3
Cataract surgery	66	34.7
Pseudophakia	62	32.6
Glaucoma	48	25.3
Reduced corneal sensation	38	20.0
Herpes simplex keratitis	33	17.4
Corneal graft	21	11.1
Bullous keratopathy	17	8.9
Dry eye	15	7.9
Trichiasis	12	6.3
Aphakia	11	5.8
Herpes zoster ophthalmicus*	10	5.3
Rubeosis iridis	8	4.2
Trauma	7	3.7
Exposure	6	3.2
Corneal scarring	6	3.2
Topical steroid use	4	2.1
Failed corneal graft	4	2.1
Uveitis	4	2.1
Recurrent erosion	3	1.6
Loose suture/suture related	3	1.6
Entropion	3	1.6
Cicatrising conjunctivitis	3	1.6
Contact lens	2	1.1
Foreign body	1	0.5
Other†	5	2.6
Any	178	93.7
More than 1 risk factor	42	22.1

*Two patients had active HZO, the remaining eight had a previous history of HZO.
†Including trachoma, corneal calcification, phthisis bulbi, scleritis, and peripheral ulcerative keratitis.

Microbiology

Corneal scrapes were taken for microbiological investigation in 172 (90.5%) patients. In addition, 66 (34.7%) patients were tested variously for HSV as follows: 42 (22.1%) with PCR, 32 (16.8%) with DFA assay, 20 (10.5%) with viral serology, and four (2.1%) with viral culture.

In only 25 (14.5%) patients were organisms identified on the Gram stain, most of these being Gram positive cocci (16), with Gram positive bacilli in five cases, and Gram negative bacilli in five cases, and multiple types in two patients.

Organisms were cultured in 108 (62.8%) of those where scrapes were taken, with more than one organism in 12 (11.1%) of those culture positive patients. The types of organism identified are shown in table 3, and the antibiotic susceptibilities as stated in the laboratory reports, are shown in table 4. Topical antibiotics had been used before presentation in 25 (39.1%) of the culture negative patients, and 41 (38.0%) of culture positive patients.

Fifteen of the 42 patients (36%) tested with HSV-PCR were positive. Of these 15 positive patients, nine (60%) had no previous history of herpetic eye disease, and seven (47%)

Table 2 Identified systemic risk factors

Risk factor	No	%
Diabetes	21	11.1
Cerebrovascular accident (CVA)	17	8.9
Rheumatoid arthritis	14	7.4
Connective tissue disease	7	3.7
Dementia	7	3.7
Myeloproliferative	5	2.6
Chronic alcoholism	4	2.1
Severe malnourishment	2	1.1
Brainstem tumour	1	0.5
At least 1 risk factor	53	27.9

Table 3 Organisms cultured

Organism	No	%
Staphylococcus sp	52	47.2
Coagulase negative *Staphylococcus*	30	27.8
Staphylococcus aureus	22	20.4
Streptococcus sp	13	12.0
Strep pneumoniae	6	5.6
β haemolytic *Streptococcus*	3	2.8
Corynebacterium sp	14	6.5
Other Gram positive	3	2.8
Total Gram positive	82	75.9
Pseudomonas sp	14	13.0
P aeruginosa	12	11.1
Bacillus sp	4	3.7
Moraxella sp	5	4.6
Other Gram negative	5	4.6
Total Gram negative	28	25.9
Fungi	4	3.7
Nocardia sp	2	1.9
Acanthamoeba	2	1.9
More than 1 organism	12	11.1
Total with positive culture	108	

were culture negative for bacteria. In contrast, only one of 32 patients (3.1%) who were tested with HSV-DFA was positive, and all four patients tested with viral culture were negative.

There were 19 patients in whom both PCR and DFA assays were performed for HSV, and of these, nine had positive HSV-PCR (47%), but all were negative on HSV-DFA testing. Of the serological tests for HSV, 19 (95%) of the 20 patients tested were IgG positive, indicating previous exposure, but all 20 were negative for IgM. HSV infection was suspected as a contributory factor in 43 (22.6%) patients overall.

Clinical features

Consistently encountered clinical features are summarised in table 5. Perforation, descemetocele, or severe thinning occurred in 12 (80.0%) of the 15 patients who were HSV PCR positive compared to 42 (30.4%) of the 138 patients with purely bacterial keratitis, and 69 (36.3%) patients overall.

Treatment

First line treatment in the majority of patients consisted of a standard regimen of intensive fortified topical antibiotics in the form of cephalothin 5% and gentamicin 0.9% on an alternating half hourly basis for the first 24–48 hours (table 6). This was then tapered according to clinical response. This regimen was used in 129 (67.9%) patients. A further 29 (15.3%) patients were given intensive topical fluoroquinolone monotherapy (either ofloxacin 0.3% or ciprofloxacin 0.3%) on a similar basis. Antiviral therapy was used in 60 (31.6%) patients.

The mean duration of topical antibiotic treatment was 3.8 (2.9) weeks (excluding postoperative prophylactic antibiotics). Initial antibiotic treatment was modified in 28 (14.7%) patients in light of microbiology results.

Acute surgical intervention was required in 83 (43.7%) patients (table 7), with acute penetrating keratoplasty (PK) performed in 34 (17.9%), and 17 (8.9%) requiring removal of the eye. Of the 14 patients who were culture positive for *Pseudomonas* sp, nine (64%) required some surgical intervention, with loss of the eye in three (21%), and acute PK in three (21%) patients

Complications

Complications occurred in 93 (48.9%) patients overall, with more than one complication in 11 (5.8%). Details are summarised in table 8.

Visual outcome

Mean presenting visual acuity was 1.82 (1.24), equivalent to 6/300, excluding 50 (26.3%) patients with vision of LP or worse. Mean visual acuity at last follow up was 1.24 (1.16), equivalent to 6/100, excluding 37 (19.5%) patients with vision of LP or worse ($p<0.0005$). Table 9 summarises the visual outcome among the viral and non-viral keratitis groups. There were 36 (18.9%) patients with visual acuity of at least 6/12 at last follow up, compared to 13 (6.8%) at presentation, and 79 (41.6%) patients who had visual acuity of worse than 6/60 at last follow up. Importantly, this left 16 (8.4%) patients legally blind because of pre-existing contralateral poor vision.

DISCUSSION

Patient demographics

The elderly make up a significant proportion of patients admitted to hospital with severe infective keratitis. We found 190 patients of 60 years and over with this diagnosis admitted to the Sydney Eye Hospital, a large tertiary referral teaching hospital, over a 4 year period. Over the same period, a total of 426 patients were admitted to our unit with this diagnosis. Those over 60 therefore constitute 45% of total admissions for infective keratitis at our unit.

Kunimoto *et al*[2] studied 102 cases of microbial keratitis in the over 65s, over a 4 year period, at a tertiary referral centre in rural southern India. Their group had a mean age of 69, with a significant male preponderance (70.6%). The setting of that study, in a rural tropical region of southern India, contrasts with our study in the temperate zone of Sydney, Australia. We found only a minimal male preponderance in our group, compared to over 70% in the study by Kunimoto, and we found, beyond the age of 80, females were over-represented. This may be because, in our study, 70 (36.8%) patients were 80 years or over, compared to only six (5.9%) patients in the study by Kunimoto. In the only previous study

Table 4 Antibiotic susceptibilities

	Chloramphenicol		Ciprofloxacin		Gentamicin		Penicillin		Cephalothin	
	No	%	No	%	No	%	No	%	No	%
Staphylococcus sp	35 (41)	85.4	25 (28)	89.3	3 (7)	42.9	13 (43)	30.2	34 (39)	87.2
Staph aureus	15 (16)	93.8	10 (12)	83.3	1 (4)	25.0	1 (16)	6.3	16 (16)	100.0
Coag negative *Staphylococcus*	20 (25)	80.0	15 (16)	93.8	2 (3)	66.7	12 (27)	44.4	18 (23)	78.3
Streptococcus sp	8 (8)	100.0	2 (2)	100.0	0 (2)	0.0	8 (8)	100.0	2 (2)	100.0
Corynebacterium	6 (8)	75.0	6 (7)	85.7	–	–	11 (12)	91.7	6 (6)	100.0
Pseudomonas	–	–	12 (12)	100.0	14 (14)	100.0	–	–	9 (9)*	100.0

Numbers shown are number of sensitive isolates (total tested).
*Ceftazidime.
Percentages are percentage of sensitive isolates.

Table 5 Clinical features (numbers shown are number of patients (%))

	All patients	HSV*	HSV PCR +†	Bacterial	HSV + bacterial	Gram positive	Gram negative
Epithelial defect	166 (87.4)	27 (87.1)	12 (80.0)	119 (86.2)	12 (100.0)	65 (90.3)	22 (78.6)
Infiltrate	132 (69.5)	11 (35.5)	7 (46.7)	106 (76.8)	7 (58.3)	54 (75.0)	21 (75.0)
Anterior uveitis	105 (55.3)	11 (35.5)	6 (40.0)	81 (58.7)	9 (75.0)	47 (65.3)	21 (67.9)
Hypopyon	55 (28.9)	3 (9.7)	1 (6.7)	50 (36.2)	2 (16.7)	25 (34.7)	13 (46.4)
Oedema	46 (24.2)	7 (22.6)	4 (26.7)	30 (21.7)	5 (41.7)	14 (19.4)	7 (25.0))
Necrosis/thinning	34 (17.9)	8 (25.8)	8 (53.3)	23 (16.7)	3 (25.0)	15 (20.8)	7 (25.0))
Perforation	23 (12.1)	9 (29.0)	3 (20.0)	13 (9.4)	1 (8.3)	7 (9.7)	2 (7.1)
Descemetocele	12 (6.3)	5 (16.1)	1 (6.7)	6 (4.3)	1 (8.3)	3 (4.2)	0 (0.0)
Vascularisation	21 (11.1)	6 (19.4)	4 (26.7)	11 (8.0)	3 (25.0)	8 (11.1)	3 (10.7)
Raised IOP	7 (3.7)	2 (6.5)	1 (6.7)	5 (3.6)	0 (0.0)	3 (4.2)	1 (3.6)
Total	190	31	15	138	12	72	28

*Clinical or laboratory diagnosed cases of HSV keratitis.
†PCR positive cases of HSV keratitis.

of microbial keratitis in the elderly from a temperate region, Ormerod[1] studied only bacterial keratitis in 142 patients aged 65 years and over, between 1977 and 1984 at several centres in Boston and Los Angeles, United States. He found an equal sex distribution.

Predisposing factors

The vast majority (94%) of our patients had at least one identifiable risk factor. This is in common with previous age independent studies where risk factors were identified in 88–91%[4 8–10] although the overall proportion of patients with identifiable risk factors is not stated in the studies by Ormerod[1] or Kunimoto *et al*[2] in the elderly.

However, in older patients the types of risk factors differ from younger age groups. Contact lens wear and trauma, common among younger groups,[4 8 9] were uncommon in our series, but previous ocular disease and surgery accounted for the majority. This compares with Ormerod's findings, where the leading risk factors were: use of topical corticosteroids (38%), corneal scarring (33%), contact lens wear (25%), and bullous keratopathy (19%).[1] Much less frequent were trauma (5%), and ''recent'' cataract surgery (4%), although the number who had undergone previous ocular surgery is not stated. The use of contact lenses among the elderly has declined since the study by Ormerod from 25 years ago, with the advent of more modern cataract surgery techniques, and far fewer aphakic patients. Kunimoto *et al* found previous ocular disease (35%), and previous ocular surgery (29%) to be the main risk factors, very few contact lens wearers (2%) as in our study, but found a high rate of trauma (18%) among their group from rural India.[2]

Unsurprisingly, systemic risk factors are also more common in the elderly, present in 28% of our cases. Ormerod[1] found 28% with systemic risk factors, compared to 17% among the group of Kunimoto *et al*.[2] In contrast, Bourcier *et al*[9] found systemic predisposing factors in only 5.8% in their series of 291 patients with a mean age of 39.

These represent only those risk factors that are readily definable and measurable. Other factors such as mobility, access to health care, support network, socioeconomic factors, dexterity, and compliance will undoubtedly have an important impact on the older patient, and therefore their susceptibility to disease and response to treatment. These are much less easily assessed, and the risk factors stated in this study, are therefore probably an underestimate in the overall context of these patients' disease.

Table 6 Topical and systemic treatment used

	No	%
Topical treatment		
Cephalothin and gentamicin	129	67.9
Fluoroquinolone	29	15.3
Chloramphenicol	25	13.2
Antiviral	60	31.6
Antiviral (topical)	47	24.7
Antiviral (systemic)	42	22.1
Antifungal	3	1.6
Antiamoebic agent	2	1.1
Other topical treatment		
Mydriatic	125	65.8
Steroid	67	35.3
Hypotensive	47	24.7
Lubricants	35	18.4
Systemic treatment		
Antiviral	42	22.1
Antibiotics	28	14.7
Doxycycline	13	6.8
Steroid	11	5.8
Multivitamins	7	3.7

Microbiology

Our culture positive rate of 63% is similar to previous reports,[3 8–13] and 76% of cultured organisms were Gram positive in our series. In this study, we found that the microbiological spectrum is similar to recent age independent series from temperate regions of the world.[8 9 11 13 14] It is interesting that the common pathogens of the outer eye have remained relatively constant for decades, with similar results reported by Musch *et al*,[4] and Ormerod[1] 25 years ago. The latter found 66% were Gram positive, with the leading organisms being coagulase negative staphylococci (23%), *Staphylococcus aureus* (23%), *Streptococcus pneumoniae* (14%), and *Pseudomonas aeruginosa* (20%). Goldstein *et al*[14] reported a decrease in the proportion of Gram positive bacterial keratitis over the past decade, and postulated that the rise in the empirical use of fluoroquinolones in the community, may have had an effect on culture rates and patterns. However, in a similar study, Alexandrakis *et al*[12] found no such trend.

HSV was implicated in 43 (22.6%) patients. In 15 patients (7.9%) PCR for HSV was positive, suggesting active infection. Interestingly, 60% of these had no previous history of herpetic eye disease, and in half, HSV was the only organism identified. PCR has previously been shown to be a sensitive method for the detection of HSV in keratitis.[15–17] Although the numbers are small in this series, it would seem that PCR has a higher detection rate for HSV than DFA assay. Of the 19 tested by both methods, nine (47%) were positive on PCR, but all were negative on DFA assay.

Previous studies in the elderly have excluded HSV keratitis.[1 2] Our series shows significant morbidity associated with HSV in the elderly, either as a predisposing factor, in polymicrobial infection, or as the single causative pathogen. Previous age independent series of microbial keratitis have tended to focus on bacterial causes, but rates of 1.8–2.0% for

Table 7 Acute surgical interventions (numbers shown are number of patients (%))

	All patients	Viral	Mixed*	Non-viral
Penetrating keratoplasty	34 (17.9)	8 (25.8)	2 (16.7)	24 (16.3)
Tarsorrhaphy	26 (13.7)	4 (12.9)	0 (0.0)	22 (15.0)
Evisceration/enucleation	17 (9.0)	1 (3.2)	0 (0.0)	16 (10.9)
Corneal glue	9 (4.7)	7 (22.6)	0 (0.0)	2 (1.4)
Conjunctival flap	5 (2.6)	0 (0.0)	1 (8.3)	4 (2.7)
Amniotic membrane graft	3 (1.6)	0 (0.0)	0 (0.0)	3 (2.0)
Lamellar keratoplasty	2 (1.1)	0 (0.0)	0 (0.0)	2 (1.4)
Botulinum toxin ptosis	2 (1.1)	0 (0.0)	0 (0.0)	2 (1.4)
None	107 (56.3)	12 (38.7)	9 (75.0)	86 (58.5)
Any	83 (43.7)	19 (61.3)	3 (25.0)	61 (41.5)
Total	190	31	12	147

*Mixed viral and bacterial keratitis.

HSV have been reported.[8 18] It might be expected that as immunity reduces with age, the impact of herpetic eye disease may increase. Certainly a high index of suspicion for HSV as a contributor or cause of keratitis must be maintained in the elderly.

Treatment

All the main bacterial species were sensitive to at least one of the most commonly used antibiotics, although the numbers were small among some of the groups tested. In particular, we found no resistance of *Pseudomonas* to ciprofloxacin, gentamicin, or ceftazidime among those tested. Hyndiuk *et al*[11] have shown fluoroquinolone monotherapy to be clinically and statistically equivalent to standard dual fortified antibiotic therapy in bacterial keratitis in a randomised, double masked, multi centre trial. However, there have been several reports showing increasing resistance to fluoroquinolones, particularly among *Streptococcus* sp,[10 14 19] coagulase negative staphylococci,[10 12 19] and *Pseudomonas* sp.[20] We found some resistance to ciprofloxacin among the staphylococci isolated, but the majority remained sensitive. In a retrospective review of 138 cases, Gangopadhyay *et al*[13] reported an increased incidence of corneal perforation among those treated with fluoroquinolone monotherapy compared to standard dual fortified antibiotic therapy, and cautioned the use of fluoroquinolone monotherapy in severe keratitis, particularly in the elderly.

Our data support the initial empirical use of intensive fortified cephalosporin and gentamicin as first line therapy in the elderly, which the majority of our patients received. Fluoroquinolone monotherapy should perhaps not be first choice, given the resistance among some staphylococci, which was the most frequently identified organism in our series, although in vitro resistance does not necessitate lack of clinical response.

The high surgical intervention rate of 43.7% in our series is higher than reported by Ormerod (29%),[1] although similar to Kunimoto *et al* (41.2%).[2] These rates from series among the elderly are much higher than in age independent series where rates of 1.3–21.4%[8 9 18] are reported. It is likely that delayed presentation, poor nutrition or hydration, reduced immunity, co-existent disease, and poor healing contribute to the higher rate among the elderly.

Complications

Almost half the patients in our series had at least one complication. There was a high rate of perforation (12.1%), and this is reflected in the high rates of acute keratoplasty and removal of the eye. Interestingly, perforation or severe thinning occurred in 30% overall, but in over 70% of those with positive HSV PCR. This diagnosis should therefore be suspected in those who develop threatened or actual perforation. Previous series in the elderly have reported high rates of enucleation/evisceration (7%[1] and 14.7%[2]), which compares to our rate of 8.9%, whereas age independent series report rates of less than 1%.[8 9]

Visual outcome

Previous studies of infective keratitis in the elderly have not commented on presenting visual acuity.[1 2] The patients in this series had a very poor presenting mean visual acuity (6/300), excluding over 25% having LP or worse. This is unlike younger patients: Wong *et al*[8] reported mean presenting visual acuity of 0.86 (equivalent to 6/36–6/48), and Bourcier *et al*[9] reported 0.51 (6/18–6/24). Our study also highlights the poor visual outcome of infective keratitis among the elderly, with over 40% worse than 6/60, and almost 20% LP or worse at last follow up. Kunimoto *et al*[2] also found a poor outcome among the elderly with 75% worse than 20/400. Younger patients do much better, with Wong *et al*[7] reporting a mean final visual acuity of 0.36 (6/12–6/15).

CONCLUSIONS

The present study is limited by its retrospective design, the lack of a younger control group, and the heterogeneity of this difficult patient group who have multiple associated factors. It is also based on patients who were admitted to hospital, as is frequently necessary in older patients, but this will select

Table 8 Complications (numbers shown are number of patients (%))

	All patients	Viral	Mixed*	Non-viral
Scarring (visually significant)	47 (24.7)	6 (19.4)	3 (25.0)	38 (25.9)
Persistent epithelial defect	25 (13.2)	5 (16.1)	0 (0.0)	20 (13.6)
Perforation	23 (12.1)	10 (32.3)	1 (8.3)	12 (8.2)
Loss of eye	17 (8.9)	1 (3.2)	0 (0.0)	16 (10.9)
Raised IOP/glaucoma	6 (3.2)	2 (6.5)	0 (0.0)	4 (2.7)
Cataract	4 (2.1)	0 (0.0)	0 (0.0)	4 (2.7)
Other	4 (2.1)	3 (9.7)	1 (8.3)	0 (0.0)
Any complication	93 (48.9)	24 (77.4)	5 (41.7)	64 (43.5)
More than 1 complication	11 (5.8)	2 (6.5)	0(0.0)	9 (6.1)

*Mixed viral and bacterial keratitis.

Table 9 Visual outcome among viral and non-viral patient groups

	Mean preop visual acuity*	SD	Mean postop visual acuity*	SD	p Value	LP or worse† (%)	
						Presentation	Last visit
All patients	1.82 (6/300)	1.24	1.24 (6/100)	1.16	<0.0005	50 (26.3)	37 (19.5)
Viral	2.12 (6/600)	1.15	1.56 (6/200)	1.28	0.01	4 (9.3)	3 (7.0)
Non-viral	1.69 (6/300)	1.26	1.13 (6/86)	1.11	<0.0001	46 (31.3)	34 (23.1)

*logMAR visual acuity (approximate Snellen equivalent).
†Light perception (LP) or worse vision, excluded from mean calculations.

for patients with more severe disease. However, this study confirms the elderly represent a distinct clinical group in the context of microbial keratitis. Predisposing factors are very common, they present with poor vision, had a high complication and surgical intervention rate, and a poor visual outcome compared to younger patient groups. The microbiological spectrum is similar to that seen in the younger population, except that HSV is more common and may increase the risk of severe corneal thinning and perforation. Most bacterial isolates remain sensitive to currently available antibiotic preparations.

ACKNOWLEDGEMENTS

We acknowledge the support of the Sydney Eye Hospital Foundation, and the Save Sight Institute, University of Sydney.

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Competing interests: none declared

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