Contact lens wear and its complications
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CHAPTER VII

SUMMARY
Millions of people are wearing contact lenses (CLs) for refractive correction. The majority use them as an alternative to spectacles (cosmetic CL users) rather than for therapeutic reasons or the correction of aphakia. CL wearers in this thesis are referred to as cosmetic CL users, unless otherwise indicated.

Microbial ulcerative keratitis is the most serious complication of CL wear. This disorder is characterized by a corneal epithelial defect with an underlying stromal infiltrate and may cause blindness from corneal scarring or perforation. The diagnosis is made on clinical grounds whereby a negative culture does not exclude a microbial cause. Although microbiological examinations have a moderate sensitivity, *P. aeruginosa* is the most frequent pathogen (up to 75%) isolated from these ulcers. Despite the relatively low incidence rates of CL-induced microbial keratitis, this complication becomes an important public health concern because a very large population is at risk and this disease can cause severe ocular morbidity in those affected. Up to now, the most decisive incidence figures of CL-related microbial keratitis were provided by a study conducted by Poggio et al in the USA in 1987. The annualized incidence rates per 10,000 cosmetic CL wearers were 4.0 for daily-wear rigid gas-permeable (RGP), 4.1 for daily-wear soft CLs and 20.9 for extended-wear soft CLs. Since the publication of this study in 1989, many measures have been taken to reduce the excessively high risk of keratitis in extended-wear users. These include shortening of the maximal number of consecutive wearing days (from 30 to 7) in extended-wear, improvement in CL materials and lens-care products, and the introduction of new wearing strategies (disposable nonreusable or frequent-replacement extended-wear CLs). It is unknown whether these efforts have had any effects on the incidence rates of microbial keratitis. To investigate the current status of microbial keratitis in cosmetic CL wearers, we conducted a prospective epidemiological study. Furthermore, we performed a long-term follow-up (more than nine months) study to determine the ocular morbidity and the health care costs due to CL-associated microbial keratitis.

The results of these studies are presented in chapter 2. The annualized incidences of microbial keratitis per 10,000 CL wearers in the Netherlands were estimated to be 1.1 for daily-wear RGP, 3.5 for daily-wear soft CLs and 20.0 for extended-wear soft CLs. It is notable that the incidence rate of the extended-wear group observed in our study was almost similar to that reported in the USA nine years ago. Our findings suggest that the taken action has not influenced the risk of keratitis in this lens group. Based on our results, we estimate that 368 cases of CL-associated microbial keratitis will develop in the Netherlands per year. Approximately
5% of the case patients with CL-related microbial keratitis achieved a final visual acuity of 20/70 or less, meaning a profound loss of vision in 20 cosmetic CL wearers per year in our country. *P. aeruginosa* was the main cause of this infection and was responsible (together with *Acanthamoeba*) for severe visual morbidity and high medical costs. *Serratia marcescens* was the next most frequent organism cultured, and seemed to be a more common pathogen in CL-associated keratitis than previously recognized. The cost-of-illness study provided some insight into the social financial burden of CL-associated microbial keratitis. The minimal disease costs were estimated to be US$2,809 per case patient. This is an underestimate because costs associated with reduced productivity at work and reduced quality of life as a consequence of decreased vision, were not included. Despite numerous studies on the pathogenesis of CL-associated microbial keratitis, the underlying mechanisms of this sight-threatening complication are still not exactly known. The minimal requirements for infection are a corneal epithelial defect and the presence of pathogenic organisms. A third factor, mucosal immunity, involves the role of specific antibodies (tear s-IgA) in the prevention of bacterial attachment to the epithelium by the formation of an antibody-bacterium complex. Because the bacterial adherence to host epithelial cells is the first step of the infectious process, decrease of specific antiadherence antibodies may lead to an enhancement of the risk of bacterial invasion. To date, the presence of specific anti-*P. aeruginosa* IgA in the tears of CL wearers had not been determined and was therefore the purpose of the study described in chapter 3. Two interesting findings were observed. First, a significant lower level of anti-*P. aeruginosa* response was noticed in the extended-wear CL users compared to the non-CL users. Second, in 17% of the CL wearers, an anti-*P. aeruginosa* response could not be detected (nonresponders). We hypothesized that the extended-wear CL users with a decreased mucosal immunity and especially the nonresponders, may be susceptible to *P. aeruginosa* keratitis when their cornea is compromised and their lenses are contaminated with this bacterium. Strong evidence for this hypothesis may be obtained by investigating the local immune response in a case-control study in CL wearers with microbial keratitis. Although controversial, the presence of lens deposits, is another factor that has been implicated in the pathophysiology of CL-associated microbial keratitis. As stated before, the initial step of infection involves the interaction of the microorganism with the host epithelial cells. The result of this interaction will determine whether the microbial contamination leads to inflammation or to elimination of the pathogen. The adhesion of *P. aeruginosa* to the corneal epithelial cells is mediated by receptor and ligand interaction. Sialic acid, a moiety of glycoproteins of tear mucins
may be the receptor for *P. aeruginosa*. Lens deposits contain mucins and may facilitate the bacterial attachment to CLs. The CL with its adherent bacteria then acts as a reservoir of potentially pathogenic organisms that initiates infection when trauma to the corneal epithelium occurs. Disposable extended-wear soft CLs, introduced in 1987, had several theoretical advantages, including the elimination of deposit-related complications. It was hoped that this lens type would decrease the incidence of CL-associated microbial keratitis. The presumed safety of disposable extended-wear CLs is partly based on the concept that deposit formation will not develop during the short wearing period (1-2 weeks) of a disposable lens. In chapter 4, we tested this hypothesis. The results showed that besides the detection of an as yet unidentified tear protein, the accumulation of deposits on CLs was already abundant after 2 days wear. Thus, if lens deposits play any role in the pathogenesis of CL-associated microbial keratitis, disposable extended-wear soft CLs should be discarded after the end of the day’s wear. In the mean time, this cryptic 30 kD protein has been identified as the dimer of tear lysozyme. At this moment, the clinical significance of this denatured form of lysozyme on CLs is unknown.

Chapters 2 to 4 concerned CL for cosmetic use. In chapter 5, an example of a medical application of CL is discussed. In this chapter the feasibility of fitting of mild keratoconus patients with an aspherical (spher-elliptical) high oxygen permeable rigid CL was tested. Furthermore the value of a computer-aided fitting system that calculates the base curve radius of the trial lens was assessed. Keratoconus is the most common ectatic dystrophy of the cornea. It is characterized by localized stromal thinning and a progressive alteration of corneal topography. In the mildest cases, the vision can be corrected with glasses. As the disease progresses, spectacle correction will be insufficient because of increasing irregular corneal astigmatism. Rigid CLs are then the choice of treatment prior to corneal transplant surgery. In the past, keratoconus patients have been fitted with spherical low oxygen permeable lenses. Because a spherical base curve would not be parallel to the aspherical peripheral area of the keratoconic cornea, excessive bearing at the apex occurred, resulting in mechanical trauma and apical scarring. In addition, the low oxygen permeable lens material caused oxygen shortage under the lens, leading to epithelial edema and poor comfort. The results of this study demonstrated that the aspherical lens design made it possible to let the back surface of the CL run parallel with the conic cornea (as shown by the even fluorescein distribution pattern) thereby avoiding the apical compression. The good fit resulted in better tear exchange under the lens. In combination with the high gas permeability, the cornea physiology and the visual function improved.
The computer-aided fitting procedure was considered to be helpful, because a very high correlation was found between the computer-calculated base curve radius of the trial lens and the base curve radius of the final selected lens.

Finally, the discussion in chapter 6, emphasizes that the improvement in CL materials and lens-care products, and the introduction of disposable CLs did not diminish the incidence rates for CL-associated microbial keratitis. The actual risk of this sight-threatening complication is still unacceptably high in the extended-wear users. The most significant risk factor for the development of ulcerative keratitis is overnight lens wear and this wear schedule is avoidable. We express our concern about the sale of CLs by discount houses and the possible lens dispensing by mail-order services. Adequate consumer education may reduce the risk of CL-associated microbial keratitis. We recommend some basic information that CL practitioners have to give to the CL purchasers. Excimer laser PRK may be a good alternative to CL in the treatment of myopia. However, this cosmetic refractive surgery is facing several problems. Of these, the loss of the best-corrected visual acuity is the major adverse sequela of PRK because this may be permanent and cannot be treated by spectacles or CLs. The risk of loss of best-corrected vision increases with increasing preoperative myopia. This is one of the important reasons why PRK (at this state of development) cannot replace spectacles and CL for the treatment of refractive errors. With time, many PRK-associated complications may be reduced by the improvement in the laser technology, and by the new insights obtained from well-designed clinical and laboratory studies.