J. Pharm. Pharmac., 1974, **26**, 899

COMMUNICATIONS

Evaluation of the antibacterial activity of contact lens solutions

Contact lens solutions are usually classified as follows: (1) cleaning solutions, for removal of proteinaceous material deposited on the lens by the lachrymal fluid, (2) soaking solutions in which the lenses are stored in a suitably hydrated condition and are sterilized to prevent eye infection and (3) wetting or cushioning solutions in which the hydrophobic hard lens surface is converted to a hydrophilic state allowing the tear fluid to wet the lens and, in the case of patients with dry eyes or poor lachrymal secretion, to form a protective film or cushion over the lens. A number of solutions which combine these functions are available.

The solutions contain preservatives in a concentration less than that used in eye-drops as the lenses may sorb preservatives with subsequent irritation when released into the eye. Richards & McBride (1972) have shown that eye-drops differ in the time required to sterilize a bacterial inoculum and because of the lower preservative concentrations used, it was decided to determine the sterilization times for commercial contact lens solutions.

Four cleaning solutions (two of them for use with soft lenses), nine soaking solutions (three for use with soft lenses), seven wetting solutions (one for use with soft lenses) and eight multi-purpose solutions (two for use with soft lenses) were tested. The solutions contained the following preservatives—benzalkonium chloride (11), chlorbutol (3), chlorhexidine (11), cetrimide (2), phenylmercuric nitrate (2) and thiomersal (11); the figures in parentheses are the number of preparations containing the preservative. Twelve preparations contained more than one preservative and seventeen contained also sodium ethylenediaminetetraacetate (EDTA). The test organisms were *Pseudomonas aeruginosa* NCTC 6750 and *Staphylococcus aureus* NCTC 6571 (Oxford Strain) and an inoculum sufficient to give a viable count of approximately 10^6 organisms per ml of contact lens solution was used in each test. The method was that previously described (Richards & McBride, 1971), and used the inactivating medium described by Riegelman, Vaughan & Okumoto (1956) to prevent any carry over of antibacterial action.

Thirteen (46%) of the solutions tested did not sterilize the two organisms within 24 h, while only three (11%) sterilized both organisms within 1 h and five (18%) within 5 h. Only fourteen solutions (50%) sterilized *P. aeruginosa* within 5 h and only three solutions sterilized the *S. aureus* inoculum more quickly than the *P. aeruginosa*.

The three soaking solutions which sterilized in less than 1 h contained benzalkonium chloride together with either chlorbutol or EDTA or chlorhexidine and EDTA. Only two solutions, both wetting solutions, contained benzalkonium chloride as the sole preservative and without EDTA; one sterilized *P. aeruginosa* inocula within 30 min but the second solution contained viable organisms after 24 h. The viscosity of wetting solutions is increased by the addition of non-ionic polymers which can reduce the activity of the preservative if not carefully selected and this may explain the anomaly. Two solutions containing polyvinyl alcohol with benzalkonium chloride as preservative gave unsatisfactory results in that subcultures taken shortly after inoculation gave no growth after incubation while others taken later showed growth.

All solutions containing chlorhexidine also contained another preservative except for one which sterilized *P. aeruginosa* within 90 min, though requiring more than 5 h

for *S. aureus*. In contrast chlorhexidine, benzalkonium chloride and EDTA in the presence of methyl cellulose and polyvinyl alcohol in a wetting solution did not sterilize either organism within 24 h.

Only four solutions containing thiomersal sterilized both organisms in less than 24 h; chlorhexidine was present in two of these and chlorbutol in the third. Besides being slow acting preservatives, the mercurials were reported by Brown (1968) and Richards & Reary (1972) to be inhibited by EDTA, yet all eleven solutions containing thiomersal contained EDTA.

It appears that there is a large variation in the antibacterial activity of commercial contact lens solutions. Although these results were obtained using high inocula of resistant organisms, it would seem prudent to require contact lens solutions to comply with standard challenge tests.

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July 16, 1974

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The production of extracellular lipids by *Pseudomonas aeruginosa* NCTC 2000 in stationary liquid media containing macrogols

Lipids are not normally found among the products that accumulate in the growth medium when cells of *Pseudomonas aeruginosa* NCTC 2000 are grown in stationary nutrient broth culture. When small amounts of magrogols were incorporated in the media some lipid material was obtained from the cell-free culture using an extraction procedure with n-butanol. The amounts of lipid material partitioning into the organic phase were determined and the lipid classes identified.

The cells were grown at 37° for five days in 1 litre flasks containing 100 ml of Oxoid nutrient broth No. 2 to which was added 1% w/v of macrogols. The media became viscous after five days due to slime production. The cells and slime were removed by homogenization, centrifugation and precipitation of the slime by the addition of cold ethanol (Brown, Foster & Clamp, 1969). The lipid material was recovered by partition into n-butanol (Bradley & Khan, 1972).

The amount of extracellular lipid obtained was estimated by comparison with a series of calibration curves prepared with palmitic acid, triolein and a pseudomonas glycolipid, using the method of Amenta (1970). The lipid material was separated into two fractions, glycolipids and neutral lipids by separation chromatography on thin layers of silica gel G (HF 254 + 366 Merck) using development with solvent I (diethyl ether–benzene–ethanol–glacial acetic acid: 40:50:2:0·2 v/v) followed by drying and redevelopment in the same direction with the solvent II (diethyl ether–hexane; 6:94 v/v) (Freeman & West, 1966). The more polar glycolipids remained at