POOR PATIENT COMPLIANCE: ON THIN ICE

A new approach to drug delivery, thin films on IOLs, may lead to better postoperative care.

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Nanomedicine is a multidisciplinary scientific field with promising perspectives in the diagnosis and treatment of a broad variety of diseases. Tissue engineering, drug delivery, novel imaging and diagnostic methods, and gene therapy rank among the most important applications of nanomedicine, and commercialization efforts are expected to increase rapidly in the coming years. Nanotechnology applications in medical specialties such as cardiology, orthopedics, and urology hold promise to lead to new approaches to therapeutic challenges.

GREAT POTENTIAL

Ophthalmology is seen as one of the medical specialties with the greatest potential to incorporate nanotechnology advances. The relatively small size of the eye; the existence of the blood-ocular barrier; and the low permeability of drugs through the cornea, the conjunctiva, and the sclera render ocular diseases excellent candidates for research at the nanolevel. Significant progress has been made in recent decades, and the development of revolutionary treatments for a number of ocular diseases is under way.

Intraocular drug delivery nanosystems, corneal and retinal tissue regeneration, noninvasive diagnostic techniques, and gene therapies with the use of nanoparticles lie at the epicenter of current research efforts. It is reasonable to expect that nanotechnology will enable us to address sight-threatening diseases such as age-related macular degeneration (AMD) and glaucoma in the future.

Thin films, developed and characterized with nanotechnology methods, are commonly used as biomaterials because of their unique interfacial and mechanical properties. These extremely thin sheets may be developed using spin coating, spraying, dipping, or other techniques. Obstacles related to the safety and cost-effectiveness of nanotechnology research remain; however, these are not insurmountable, and thin films are expected to contribute significantly to biomedical research.

MODIFYING IOLS TO BOLSTER PATIENT COMPLIANCE

Our work regarding modified IOLs is an ongoing project, carried out as collaboration between the Second University Ophthalmology Department and the Laboratory of Thin Films and Nanotechnology of Aristotle University of Thessaloniki in Greece. Our aim is to address the issues related to postoperative application of eye drops after cataract extraction.

Patients' poor compliance with postoperative drop regimens is a common problem, and it is related to a number of factors that include memory issues and arthritis. Lack of compliance can lead to severe complications that could be prevented if patients used their drops properly. We have, therefore, designed and developed a novel drug-delivery system that may provide sufficient antibiotic and antiinflammatory postoperative treatment to cataract patients.

BY THE NUMBERS*

GROWTH OF NANOMEDICINE

US$1.3 TRILLION

The estimated global nanomedicine market by 2025

16.6% Compound annual growth rate in naonmedicine over the next decade

*Statistics courtesy of Global Nanomedicine Market Analysis and Trends—Industry Forecast to 2025

AT A GLANCE

- A thin-film, polymer coating for IOLs that biodegrades over a period of 6 weeks has been shown to release a therapeutic substance at a controlled rate.
- Such preparation of therapeutically customized IOLs capable of responding to each patient's needs could have the potential to eliminate the need for postoperative treatment with eye drops.

Modification of IOLs in order to improve their physical properties has been the objective of a number of interesting studies. My colleagues and I have developed a polymer coating for IOLs that biodegrades over a period of 6 weeks, releasing a therapeutic substance at a controlled rate. Initially, this coating was developed on a flat metal surface, and we then proceeded with the challenge of applying it to the surface of an IOL. Our method of choice was spin coating, which we found did not damage the integrity of the lens. Modified lenses were then folded in injectors, and this process did not affect the thin films either.

CURRENT STUDIES, FUTURE HOPES

Our study of the modified lens has demonstrated that its optical properties remain unaffected, as the thin films that are applied to its surface do not influence its transparency. Atomic force microscopy and scanning electron microscopy studies have shown that the structure of the films is porous, and this allows concentration of the therapeutic substance in these pores during the fabrication of the film.

Studies of the rate of drug release have produced promising results. So have in vitro toxicity studies, in which no cellular toxicity was noted. Our plans include further research with different or multiple substances, as well as in vivo experiments. Preparation of customized IOLs capable of responding to each patient's needs is our ultimate goal. If achieved, this could eliminate the need for postoperative treatment with eye drops in the future.

CONCLUSION

Our experience in this joint project underscores the importance of interdisciplinary collaborations in scientific research. Nanotechnology has proved to be an especially valuable pathway to approach complicated ophthalmologic problems, and it will undoubtedly influence the future of research in our field. Serious challenges remain to be addressed, as cooperation among scientists from different fields requires great effort; however, it is reasonable to expect that interdisciplinary research may lead to marvelous achievements in the future. ■

FIFTEEN COMPANIES THAT ARE LEADING THE WAY IN NANOMEDICINE*

- 3M COMPANY
- ABBOTT LABORATORIES
- CELGENE CORPORATION
- COMBIMATRIX
- GE HEALTHCARE
- JOHNSON & JOHNSON
- MALLINCKRODT PHARMACEUTICALS
- MERCK & CO
- NANOSPHERE
- PFIZER
- SIGMA-TAU PHARMACEUTICALS
- SMITH & NEPHEW
- STRYKER
- TEVA PHARMACEUTICAL INDUSTRIES
- UNION CHIMIQUE BELGE

* Source: Global Nanomedicine Market Analysis and Trends—Industry Forecast to 2025

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