2024-2025 Bioengineering Colloquium Series

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Antimicrobial blue light inactivation of microbial pathogens: State of the art

Although microbiologists have been ringing the alarm bell for years, the threat of antibiotic resistance has reached new prominence in the popular press that the issue should be added to the list of global emergencies. It is now indisputable that antibiotic resistance is life-threatening in the same sense as cancer, both in the number of cases and the likely outcome. New therapeutic approaches are urgently needed to combat antibiotic-resistant microbial pathogens. In response, the United States Government has recently accelerated efforts to advance innovative research on antibiotic resistance, with special attention to the treatment of multidrug-resistant Gram-negative bacteria, which are of particular concern because of their diverse and rapidly evolving mechanisms of resistance (White House. National Action Plan for Combating Antibiotic-Resistant Bacteria 2020-2025).

Antimicrobial blue light (aBL) in the spectrum of 400-470 nm, as an innovative non-antibiotic approach, has demonstrated its intrinsic antimicrobial activity resulting from the photoexcitation of naturally occurring endogenous photosensitizing chromophores in microbial pathogens and the subsequent production of cytotoxic reactive oxygen species. In this tutorial, I will present an overview of our laboratory's recent efforts in exploring the utility of aBL for treating antibiotic-resistant localized infections. Topics will include the susceptibilities of Gram-negative bacteria and other pathogens to killing by aBL, mechanism of action of aBL, synergism of aBL with traditional antibiotics for enhanced antimicrobial activity, potential side effects of aBL on the host cells and tissues, the development of novel optical devices for infection treatment, preclinical studies of aBL therapy for localized infections (e.g., skin wound infections, keratitis, implant-related infections, etc), and future directions in the field of aBL therapy.

Biography

Dr. Tianhong Dai is an Associate Professor with the Wellman Center for Photomedicine, Massachusetts General Hospital, Harvard Medical School. From 2002 to 2006, he was a postdoc in Dr. Bahman Anvari's lab at the Rice University. Dr. Dai is a recognized world expert in antimicrobial photodynamic therapy and antimicrobial blue light therapy for multidrug-resistant infections. His past research has resulted in over 130 publications in peer-reviewed journals with an h-factor of 61 and >16,000 citations (Google Scholar data), and over 20 invited, plenary, and keynote presentations at national and international conferences. In addition, Dr. Dai has been the PI of independent grants from the NIH (R01, R21, and R13), DoD, ASLMS, and various other funding agencies, totaling over $8 million in direct cost. Dr. Dai's professional recognition has also been evidenced by his service on the grant review panels (or study sections) at the NIH, DoD/CDMRP, NSF, Harvard Catalyst, French National Research Agency, Ministry of Education of Singapore, and Leibniz Association of Germany, etc. He was also a member of the FDA/CBER Laboratory Site Visit Review Team.

Dr. Dai is the Founding Chair of the conference "Photonic Diagnosis, Monitoring, Prevention, and Treatment of Infectious Diseases" at the SPIE Photonics West BiOS and the Symposium Chair of the "COVID-19 Application Track" at the SPIE Photonics West BiOS. He also holds key editorial roles, serving as Editor-in-Chief of "Recent Advances on Anti-Infective Drug Discovery", Associate Editor of "Lasers in Surgery and Medicine", and Theme Editor of "Advanced Drug Delivery Reviews". He is also an Editorial Board Member of several peer-reviewed journals, such as the "Journal of Photochemistry and Photobiology", "Photobiomodulation, Photomedicine, and Laser Surgery", etc.

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