

Oxidative Stress in Applied Basic Research and Clinical Practice

Editor-in-Chief

Donald Armstrong

For further volumes:

<http://www.springer.com/series/8145>

Note from the Editor-in-Chief

All books in this series illustrate point-of-care testing and critically evaluate the potential of antioxidant supplementation in various medical disorders associated with oxidative stress. Future volumes will be updated as warranted by emerging new technology, or from studies reporting clinical trials.

Donald Armstrong
Editor-in-Chief

Nirmal K. Ganguly • Surinder K. Jindal
Shyam Biswal • Peter J. Barnes
Ruby Pawankar
Editors

Studies on Respiratory Disorders

 Humana Press

Editors

Nirmal K. Ganguly
Department of Biotechnology
National Institute of Immunology
New Delhi, India

Surinder K. Jindal
Department of Pulmonary Medicine
Postgraduate Institute of Medical Education
and Research
Chandigarh, India

Shyam Biswal
Department of Medicine and Oncology
Johns Hopkins College of Medicine
Baltimore, MD, USA

Peter J. Barnes
National Heart & Lung Institute
Imperial College London
London, UK

Ruby Pawankar
Division of Allergy
Department of Pediatrics
Nippon Medical School
Bunkyo-ku, Tokyo, Japan

ISSN 2197-7224

ISSN 2197-7232 (electronic)

ISBN 978-1-4939-0496-9

ISBN 978-1-4939-0497-6 (eBook)

DOI 10.1007/978-1-4939-0497-6

Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2014933268

© Springer Science+Business Media New York 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Humana Press is a brand of Springer
Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Oxygen species constitute an important vehicle of damage in disease pathogenesis including several respiratory diseases. Although the information has been available for more than four decades, it had been difficult to attribute a specific role to oxidative stress in a cause-and-effect relationship. In respiratory medicine, some of the earlier studies had focused on pulmonary infections, including tuberculosis. Advances in the study of volatile organic components in the expired air have made it possible to examine some of the hitherto not understood mechanisms in different pulmonary diseases, particularly the airway disorders. We now recognize the wide spread involvement of oxygen species as well as of nitrogen-free radicals in airway diseases, such as asthma and chronic obstructive pulmonary disease. Numerous reports have appeared in the last two decades which demonstrate an imbalance of oxidant–antioxidant mechanisms in many other respiratory disorders such as the interstitial lung diseases, granulomatous disorders (e.g. sarcoidosis), asbestosis, muscle dysfunction, pulmonary hypertension, and thoracic cancers.

It is the therapeutic potential of antioxidant drugs in the management of diseases which has made the subject as particularly interesting to the clinicians. Unfortunately, we do not yet have a drug known for its proven therapeutic efficacy for almost any disorder. Numerous drugs are under investigation for possible supplemental roles in therapy of different disorders. One hopes for rapid development of drugs which, in addition to the primary therapy, will be able to act on specific target species for disease arrest and/or reversal.

We have written this monograph with a dual purpose—first to review the existing and up-to-date knowledge on oxidative stress in different respiratory diseases, and secondly to sensitize the clinicians to continue to look to a broader scene of pathogenetic spectrum of diseases for expansion of the therapeutic armamentarium. We do hope that this monograph shall help not only the specialist pulmonologists but all others who are interested and engaged in the subject of oxidative damage.

Chandigarh, India
New Delhi, India

Surinder K. Jindal
Nirmal K. Ganguly

Contents

| | |
|---|------------|
| 1 Introduction to Oxidative Stress and Antioxidant Therapy in Respiratory Disorder..... | 1 |
| Francesco Galli, Massimo Conese, Luigi Maiuri, Roberto Gambari, Desirée Bartolini, Marta Piroddi, Silvia Ciffolilli, and Giulio Cabrini | |
| 2 Reactive Oxygen and Nitrogen Species: General Considerations..... | 27 |
| Veena Dhawan | |
| 3 Role of Exhaled Biomarkers, Volatiles, and Breath Condensate..... | 49 |
| Yan Liang and Lou Ann S. Brown | |
| 4 Volatile Organic Compounds as Exhaled Biomarkers of Inflammation and Oxidative Stress in Respiratory Diseases..... | 67 |
| F.J. van Schooten, A.W. Boots, A. Smolinska, and J.W. Dallinga | |
| 5 Pulmonary Infections—Oxidant Injury and Role of Antioxidants..... | 85 |
| Bidyalaxmi Devi Leishangthem, Ruchi Rastogi, and Archana Bhatnagar | |
| 6 Oxidative Stress in Tuberculosis..... | 101 |
| Indu Verma, Surinder K. Jindal, and Nirmal K. Ganguly | |
| 7 Oxidative Stress in COPD..... | 115 |
| Peter J. Barnes | |
| 8 Oxidative Injury Caused by Cigarette Smoking and Air Pollution..... | 131 |
| Andrew J. Ghio | |

| | | |
|-----------|--|-----|
| 9 | Air Pollution and Oxidative Stress in Allergic Airway Diseases | 151 |
| | Ruby Pawankar, Chika Ozu, Miyuki Hayashi, and Shingo Yamanishi | |
| 10 | Pulmonary Fibrosis and Oxidative Stress | 163 |
| | Corrine R. Kliment and Tim D. Oury | |
| 11 | Oxidative Stress in Sarcoidosis | 191 |
| | Sahajal Dhooria and Dheeraj Gupta | |
| 12 | Asbestos Fibers: Mechanisms of Injury | 203 |
| | Daniel E. Banks, Michael J. Morris, and Surinder K. Jindal | |
| 13 | Oxidative Stress and Respiratory Muscle Dysfunction | 225 |
| | Kazuto Matsunaga | |
| 14 | Oxidative Stress and Lung Cancer | 245 |
| | Aditya Jindal and Navneet Singh | |
| 15 | Pulmonary Arterial Hypertension and Oxidative Stress | 259 |
| | Izabela Chrobak, Christina Mallarino Haeger, Marcy E. Maracle, and Laura E. Fredenburgh | |
| 16 | Role of Oxidants and Antioxidants in Pediatric Respiratory Disorders | 327 |
| | Meenu Singh and Anil Chauhan | |
| 17 | Oxidative Stress and Respiratory Diseases: The Critical Role of Nrf2 | 335 |
| | Thomas E. Sussan and Shyam Biswal | |
| 18 | Development of Novel Antioxidants | 349 |
| | Subhabrata Moitra, Sneha Limaye, and Bill Brashier | |
| 19 | Ayurvedic and Other Antioxidant Mimics | 369 |
| | Samir Malhotra and Amritpal Singh | |
| | About the Editors | 381 |
| | Index | 385 |

Contributors

Daniel E. Banks Department of Medicine, Uniformed Services University of Health Sciences, Fort Sam Houston, TX, USA

Peter J. Barnes Airway Disease Section, National Heart & Lung Institute, Imperial College London, London, UK

Desirée Bartolini Department of Pharmaceutical Sciences, University of Perugia, Perugia, Italy

Archana Bhatnagar Department of Biochemistry, Panjab University, Chandigarh, India

Shyam Biswal Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

A.W. Boots Department of Toxicology, Nutrition and Toxicology Research Institute Maastricht (NUTRIM), Maastricht University Medical Centre, Maastricht, The Netherlands

Bill Brashier Chest Research Foundation, Pune, Maharashtra, India

Lou Ann S. Brown Division of Neonatal-Perinatal Medicine, Department of Pediatrics, Emory University, Emory and Children's Healthcare of Atlanta Center for Developmental Lung Biology, Atlanta, GA, USA

Giulio Cabrini Department of Pathology and Diagnostics, University Hospital of Verona, Verona, Italy

Anil Chauhan Department of Pediatrics, Advanced Pediatric Center, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Izabela Chrobak Division of Pulmonary and Critical Care Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Lovelace Respiratory Research Institute, Albuquerque, NM, New Mexico

Silvia Ciffolilli Department of Pharmaceutical Sciences, University of Perugia, Perugia, Italy

Massimo Conese Department of Medical and Surgical Sciences, University of Foggia, Foggia, Italy

J.W. Dallinga Department of Toxicology, Nutrition and Toxicology Research Institute Maastricht (NUTRIM), Maastricht University Medical Centre, Maastricht, The Netherlands

Veena Dhawan Department of Experimental Medicine and Biotechnology, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Sahajal Dhooria Department of Pulmonary Medicine, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India

Laura E. Fredenburgh Division of Pulmonary and Critical Care Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Francesco Galli Department of Pharmaceutical Sciences, University of Perugia, Perugia, Italy

Roberto Gambari Department of Life Sciences and Biotechnology, University of Ferrara, Ferrara, Italy

Nirmal K. Ganguly Department of Biotechnology, National Institute of Immunology, New Delhi, India

Andrew J. Ghio Human Studies Facility, Chapel Hill, NC, USA

Dheeraj Gupta Department of Pulmonary Medicine, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Christina Mallarino Haeger Division of Pulmonary and Critical Care Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Miyuki Hayashi Department of Pediatrics, Nippon Medical School, Tokyo, Japan

Aditya Jindal Jindal Chest Clinics, Chandigarh, India

Surinder K. Jindal Department of Pulmonary Medicine, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Corrine R. Kliment Department of Internal Medicine, Brigham and Women's Hospital, Harvard University, Boston, MA, USA

Bidyalaxmi Devi Leishangthem Department of Biochemistry, Panjab University, Chandigarh, India

Yan Liang Division of Neonatal-Perinatal Medicine, Department of Pediatrics, Emory University, Emory and Children's Healthcare of Atlanta Center for Developmental Lung Biology, Atlanta, GA, USA

Sneha Limaye Chest Research Foundation, Pune, Maharashtra, India

Luigi Maiuri Department of Medical and Surgical Sciences, University of Foggia, Foggia, Italy

European Institute for Research in Cystic Fibrosis, Milan, Italy

Samir Malhotra Department of Pharmacology, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Marcy E. Maracle McGill University, Montreal, QC, Canada

Kazuto Matsunaga Third Department of Internal Medicine, School of Medicine, Wakayama Medical University, Wakayama, Japan

Yoshiaki Minakata Third Department of Internal Medicine, School of Medicine, Wakayama Medical University, Wakayama, Japan

Subhabrata Moitra Chest Research Foundation, Pune, Maharashtra, India

Michael J. Morris Pulmonary/Critical Care Service, Brooke Army Medical Center, Fort Sam Houston, TX, USA

Tim D. Oury Department of Pathology, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

Chika Ozu Ozu ENT Clinic, Shizuoka, Japan

Ruby Pawankar Division of Allergy, Department of Pediatrics, Nippon Medical School, Bunkyo-ku, Tokyo, Japan

Marta Piroddi Department of Pharmaceutical Sciences, University of Perugia, Perugia, Italy

Ruchi Rastogi Department of Biochemistry, Panjab University, Chandigarh, India

F.J. van Schooten Department of Toxicology, Nutrition and Toxicology Research Institute Maastricht (NUTRIM), Maastricht University Medical Centre, Maastricht, The Netherlands

Amritpal Singh Ayurvedic Consultant, Mohali, Punjab, India
Formerly at Ayurvedic College, Chandigarh, India

Meenu Singh Department of Pediatrics Advanced Pediatric Center, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Navneet Singh Department of Pulmonary Medicine, Postgraduate Institute of Medical Education and Research, Chandigarh, India

A. Smolinska Department of Toxicology, Nutrition and Toxicology Research Institute Maastricht (NUTRIM), Maastricht University Medical Centre, Maastricht, The Netherlands

Thomas E. Sussan Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Indu Verma Department of Biochemistry, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Shingo Yamanishi Department of Pediatrics, Nippon Medical School, Tokyo, Japan