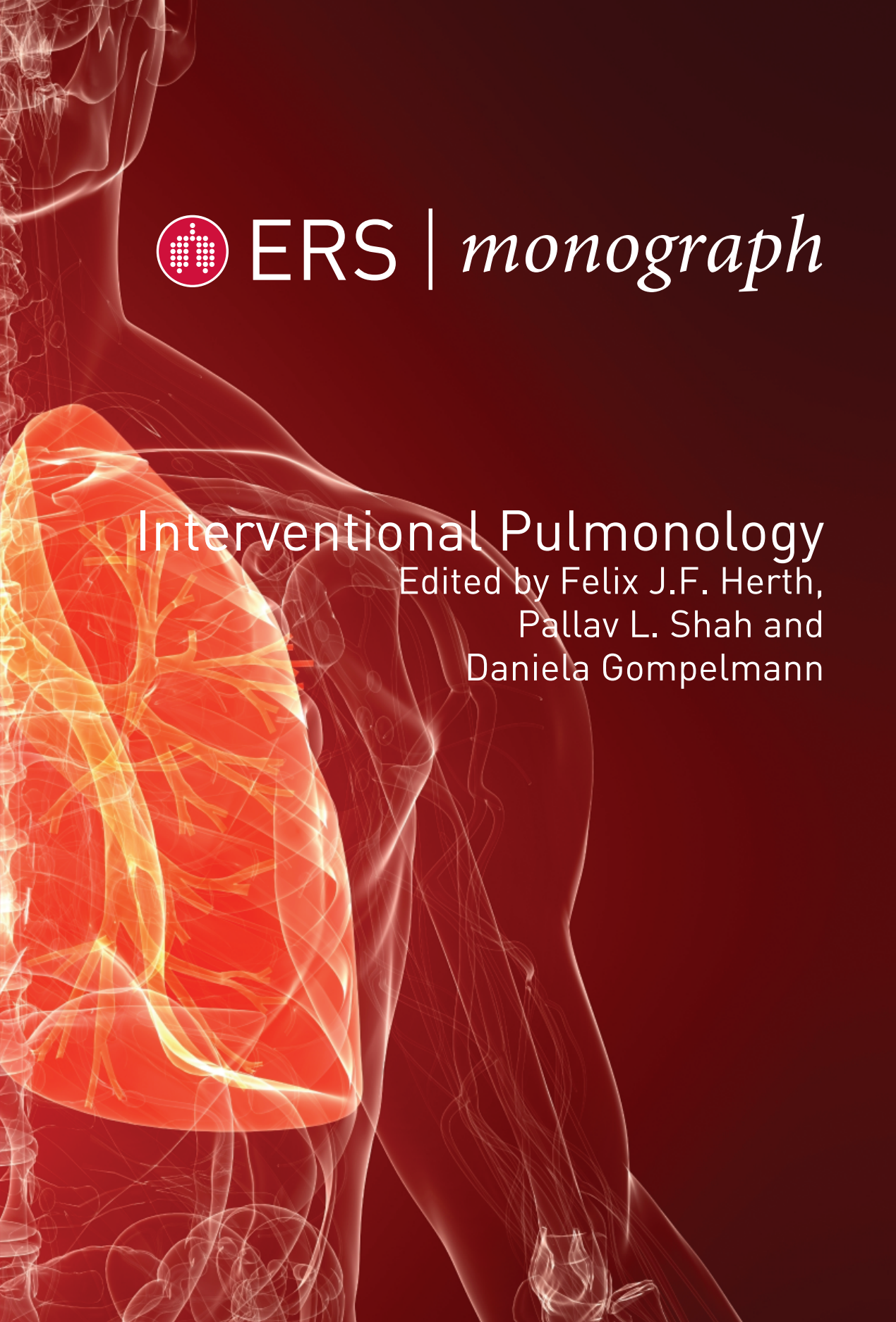
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Interventional Pulmonology
Edited by Felix J.F. Herth,
Pallav L. Shah and
Daniela Gompelmann

Interventional Pulmonology

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Editor in Chief
Robert Bals

This book is one in a series of *ERS Monographs*. Each individual issue provides a comprehensive overview of one specific clinical area of respiratory health, communicating information about the most advanced techniques and systems required for its investigation. It provides factual and useful scientific detail, drawing on specific case studies and looking into the diagnosis and management of individual patients. Previously published titles in this series are listed at the back of this *Monograph*.

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Preface

Robert Bals

Pulmonary medicine is a sub-discipline of internal medicine with several attractive characteristics. The use of endoscopic methods for diagnosis and therapy offers the opportunity to work manually and to improve patient outcomes significantly. In comparison with other specialities, pulmonary interventional methods are still underdeveloped, despite the fact that non-pharmacological treatment often provides favourable outcomes. However, the field of bronchoscopic intervention is developing quickly. In diagnosis, new biopsy techniques and targeting strategies have been developed, with the use of endoluminal ultrasound being an outstanding approach of recent decades. In therapeutics, local cancer control is one of the main fields, while interventional treatment of COPD and asthma has raised significant recent interest. Despite these exciting developments, many methods used in interventional bronchoscopy require careful patient selection and the well-developed skills of the highly trained medical team.

In this *Monograph*, we provide the reader with a broad and detailed overview of the various applications of interventional bronchoscopy. The book begins with a section on Technical Aspects, which summarises standard techniques such as flexible and rigid endoscopy. The Diagnostic Procedures section presents information about novel and targeted biopsy approaches. The final section considers Therapeutic Interventions, providing chapters on the various approaches to the treatment of cancer, haemoptysis, COPD and asthma, amongst others.

Through careful topic selection, the Guest Editors, Felix J.F. Herth, Pallav L. Shah and Daniela Gompelmann, have created a book that successfully summarises current knowledge in this area. Together with the authors, they have produced a practice-guideline publication that provides both background information and hands-on guidance for use in the endoscopy unit. I would like to thank the Guest Editors and all of the authors for their hard work on this excellent book.

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Guest Editors

Felix J.F. Herth

Felix J.F. Herth graduated at the University of Freiburg (Freiburg, Germany) and was trained at Klinikum Karlsruhe (Karlsruhe, Germany) and at the Beth Israel Deaconess Medical Center (Harvard Medical School, Boston, MA, USA).

Felix Herth is Professor of Pneumology at the University of Heidelberg (Heidelberg, Germany). His department (Pulmonary and Respiratory Critical Care Medicine) focuses on: the diagnosis and therapy of respiratory tract diseases (such as lung emphysema, cystic fibrosis, fibrosing alveolitis and pulmonary hypertension); noninvasive ventilatory support for patients with respiratory deficiency or failure; and sleep-related respiratory disorders. His team provides outstanding expertise in all fields of bronchoscopy, and takes a lead position in the development of devices for diagnostic and therapeutic purposes.

Felix Herth's research interest are lung cancer, ILDs and interventional bronchoscopy. He is a European Health Leader (Insead Business School) and works closely with the European Health commission.

Pallav L. Shah

Pallav L. Shah is currently Professor of Medicine at Imperial College London (London, UK). He is a Senior Consultant Physician at the Royal Brompton Hospital (London, UK), and the Chelsea and Westminster Hospital (London, UK). He qualified in Medicine at Guy's Hospital Medical School (London, UK) and trained in pulmonology at the Royal Brompton Hospital.

Pallav Shah is active in both the research and development of new treatments. He has had over 200 papers published and has contributed to several books, including as sectional editor of the Thoracic section of *Gray's Anatomy* (39th & 40th editions) and as sectional editor for the Respiratory section of the *Oxford Textbook of Medicine* (6th edition). He is also the author of the

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Atlas of Flexible Bronchoscopy and Chief Editor of *Essentials of Clinical Pulmonology*. He has also been involved in the HERMES (Harmonised Education in Respiratory Medicine for European Specialists) education programme for the European Respiratory Society (ERS).

Pallav Shah is experienced in the diagnosis and treatment of all aspects of respiratory disease. He is a renowned interventional bronchoscopist and is distinguished in its application in respiratory medicine. He pioneered bronchoscopic lung volume reduction for emphysema with devices such as the Zephyr endobronchial valve (Pulmonx Corporation, Redwood City, CA, USA), endobronchial coils, Vapor treatment and intrabronchial valves. More recently, he has focused on the treatment of COPD with Vapor therapy, targeted nerve ablation and the novel Rejuvinair (cryospray) (CSA Medical Inc., Lexington, MA, USA) procedure for chronic bronchitis. Pallav Shah was involved in the development of bronchial thermoplasty for asthma, and is currently assisting in the development of novel techniques for the ablation of peripheral lung tumours, which perform a range of procedures including cryotherapy and the insertion of gold markers to enable treatment with the CyberKnife.

Daniela Gompelmann

Daniela Gompelmann completed her medical training at the University of Saarland (Homburg, Germany) in 2007. She has been a consultant in the Pulmonology and Critical Care Medicine department at Thoraxklinik (Heidelberg, Germany) since 2015. Her research interests lie in the field of interventional pneumology, particularly endoscopic therapeutic procedures for patients with COPD and emphysema. She is principal investigator and head of the Junior Research Group of Interventional Pulmonology at the Translational Lung Research Center (Heidelberg, Germany), member of the German Center for Lung Research.

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Introduction

Felix J.F. Herth[1], Pallav L. Shah[2,3,4] and Daniela Gompelmann[5]

The role of bronchoscopy in the evaluation and treatment of respiratory disease has evolved dramatically over the last decade. It was initially a tool for examining and sampling the central endobronchial tree, and techniques available included simple suctioning of secretions, bronchial washing, bronchial brushing and bronchial biopsies. The latter two are achieved by inserting either a cytology brush or biopsy forceps through the instrument channel and sampling the area of direct interest. During the 1990s, there was a transition from fibreoptic bronchoscopes to video bronchoscopes. The quality of the imaging systems has improved exponentially thanks to advances in video charged coupled devices (CCDs). Initially, there was the development of fluorescence bronchoscopy and NBI for the early detection of cancer. Although these techniques have the potential to identify lesions early, they have become less important with improvements in image quality. The transition to low tar cigarettes with filters means the natural history of lung cancer has also changed from central airway squamous cell carcinomas to more peripheral adenocarcinomas. Techniques have therefore been developed for sampling peripheral lesions, such as radial ultrasound with a guide sheath and computer-aided navigation bronchoscopy (LungPoint (Broncus Medical, Inc., San Jose, CA, USA) and superDimension (Medtronic, Minneapolis, MN, USA)). With the growth in CT scanning, the identification of peripheral nodules and pulmonary abnormalities will further increase, which will in turn increase the demand for sampling in these peripheral abnormalities.

Endosonography and particularly EBUS-TBNA, with the development of the integrated linear ultrasound bronchoscope, have transformed the staging and diagnosis of lung cancer. These techniques allow sampling of multiple mediastinal and hilar lymph node stations as short day-case procedures under conscious sedation. These techniques are also useful for sampling mediastinal lymph nodes in other conditions such as sarcoidosis, and allow sampling of abnormalities adjacent to the central tracheobronchial tree.

Bronchoscopy has now truly reached its potential as a therapeutic tool. Central obstructing tumours can be debulked using either electrocautery, argon plasma photo coagulation, laser ablation or cryo-extraction. Traditional cryotherapy with repeated freeze–thaw cycles can also be used but requires a follow-up bronchoscopy to clear up necrotic tissue. PDT is a further possibility but this requires a photo-sensitiser to be administered intravenously about 72 h followed by PDT at bronchoscopy and a subsequent procedure to remove the

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debris and necrotic tissue. Where there is tumour ingress extrinsically or loss of the airway structure, endobronchial stents may be considered. These primarily have a role in supporting the trachea or main bronchi. Stents are available in a variety of forms, from SEMS (which may be bare, partly or fully covered) to silicon stents.

Bronchoscopic lung volume reduction using endobronchial valves has been established as part of optimal medical treatment, as a treatment for severe hyperinflation and for use in the absence of collateral ventilation. Alternative approaches that are being developed include endobronchial coils, vapour therapy (which uses the fibrotic effects of thermal ablation) and chemical fibrotic agents. In COPD, ablation of the vagus nerve using radio frequency ablation of the nerve plexus surrounding the main bronchi is at an advanced phase of development. Cryospray therapy with liquid nitrogen is also in development for the treatment of chronic bronchitis. Bronchial thermoplasty has been shown to be effective in a wide group of asthma patients and has been available for about 10 years.

Bronchoscopy has evolved from a simple visual tool that relies on light, to an imaging tool with integrated ultrasound that allows sampling of parabronchial and mediastinal abnormalities. Its true potential is the increasing number of conditions that may be treated using a bronchoscopic approach.

Disclosures: F.J.F. Herth has received personal fees from the following, outside the submitted work: Olympus, Pulmonx, BTG, Uptake, Broncus, BSI and Erbe. P.L. Shah has received personal fees from the following, outside the submitted work: Olympus, PneumRX/BTG, Broncus, Medtronic, Creo Medical and Holairia. On behalf of Imperial College, P.L. Shah has also received sponsorship from the following for a bronchoscopy course: ERBE, Cook Medical, Medtronic, Boston Scientific, Aquilant, Broncus, Pulmonx, Olympus and PneumRX. D. Gompelmann reports receiving personal fees, outside the submitted work, from the following: PulmonX, Olympus, Chiesi, Novartis, Boehringer Ingelheim, Berlin Chemie, AstraZeneca and Mundipharma.

List of abbreviations

AFB	autofluorescence bronchoscopy
APC	argon plasma coagulation
BAL	bronchoalveolar lavage
COPD	chronic obstructive pulmonary disease
CT	computed tomography
EBUS	endobronchial ultrasound
EDAC	excessive dynamic airway collapse
ENT	ear, nose and throat
EUS	endoscopic ultrasound
FEV1	forced expiratory volume in 1 s
HRCT	high-resolution CT
ILD	interstitial lung disease
NBI	narrow band imaging
OCT	optical coherence tomography
PDT	photodynamic therapy
PET	positron emission tomography
RFA	radiofrequency ablation
SBRT	stereotactic body radiation therapy
SEMS	self-expandable metallic stents
TBB	transbronchial biopsy
TBLB	transbronchial lung biopsy
TBNA	transbronchial needle aspiration
VATS	video-assisted thoracoscopic surgery