

Respiratory Medicine  
Series Editor: Sharon I.S. Rounds

Stephanie D. Davis  
Ernst Eber  
Anastassios C. Koumbourlis *Editors*

# Diagnostic Tests in Pediatric Pulmonology

Applications and Interpretation



*We help the world breathe!*  
PULMONARY • CRITICAL CARE • SLEEP



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# Preface

Over the past 20 years, diagnostic tests for pediatric pulmonologists have revolutionized care of children afflicted with respiratory disorders. These tests have been used to help not only in diagnosis but also in the management and treatment of these children. Bronchoscopic, imaging, and physiologic advances have improved clinical care and have also been used as outcome measures in research trials.

The aims of this book are to (1) describe the various diagnostic modalities (especially the newer ones) that are available for the evaluation of pediatric respiratory disorders; (2) understand the advantages and limitations of each test so that the clinician may choose the most appropriate modality; and (3) describe how best to interpret the key findings in a variety of tests as well as the possible pitfalls in interpretation.

The book focuses on the main diagnostic modalities used in the evaluation of pediatric patients with respiratory disorders and presents up-to-date information on a number of tests that are used for a variety of conditions encountered in the practice of pediatric pulmonology. The clinical applications of the tests are highlighted within each chapter.

The book contains 14 chapters written by 30 authors; the authors are both young pediatric pulmonologists who are emerging as leaders in our field as well as well-known international experts.

Target readers are practicing clinicians including pediatric pulmonologists, intensivists, pediatricians, and primary care practitioners. Other readers may include trainees, respiratory therapists, nurses, radiologists, and clinical researchers.

We would like to thank the staff at Springer, especially Maureen Alexander and Amanda Quinn, for endorsing and editing the book. We especially would like to thank our expert authors for writing such detailed and outstanding chapters. Finally, we would like to thank our families for their continual love, support, and encouragement during this endeavor.

Indianapolis, IN, USA  
Graz, Austria  
Washington, DC, USA

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Ernst Eber  
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# Chapter 1

## The Evaluation of the Upper and Lower Airways in Infants and Children: Principles and Pearls from Four Decades in the Trenches

**Robert E. Wood**

**Abstract** Diagnostic bronchoscopy is an often underutilized technique in pediatric patients. However, with proper equipment, appropriate technical and cognitive skills, and effective and careful attention to safety and comfort, bronchoscopy can be a powerful tool for the pediatric pulmonologist. This review is a distillation of the author's four decades of experience.

**Keywords** Flexible bronchoscopy • Airway dynamics • Sedation/anesthesia for pediatric bronchoscopy • Airway management for pediatric flexible bronchoscopy • Indications for pediatric flexible bronchoscopy • Complications of pediatric flexible bronchoscopy • Techniques for pediatric flexible bronchoscopy • Clinical utility of pediatric flexible bronchoscopy

Bronchoscopy is a powerful diagnostic and therapeutic tool for the evaluation and management of children with pulmonary or airway issues. During the 1970s, dramatic progress was made in the development of instrumentation suitable for pediatric bronchoscopy, including the glass rod telescope for rigid instruments and a flexible bronchoscope small enough to be safely used in children. Over the ensuing nearly four decades, further progress has been made in instrumentation as well as experience in the utilization of these instruments.

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The discussion in this chapter is predicated on the assumption that the operator will be equipped with the proper equipment (which is properly cleaned and prepared for use in the patient), trained assistants, a proper venue, appropriate provision for sedation/anesthesia and monitoring of the patient's physiologic status, and a plan for safe recovery from the sedation, and that the parents/guardians have provided appropriate informed consent.

This chapter is primarily a distillation of my personal experience over the past four decades of spelunking in the pediatric airways. The views expressed are mine, and are based on more than 20,000 procedures. I have made (and learned from) many mistakes ... my practices and perspective have evolved over this time.

## Principles

There are four criteria for successful bronchoscopy: (1) safety, (2) safety, (3) comfort, and (4) achieving the correct diagnosis or result.

Other than death of the patient, the most serious complication of a bronchoscopy is to have done the procedure but obtained the wrong diagnostic or therapeutic result.

Match the instrument(s) to the patient and purpose of the procedure.

Be aware of the effect of sedation level and body position as well as the effect of the instrument itself and techniques utilized for airway management on the visualized anatomy and airway dynamics.

The airways begin at the nostril ....

Children often have more than one significant airway abnormality—examine the entire airway unless contraindicated.

“WNL” too often really means, “We Never Looked.”

The endoscopic findings must be interpreted *in the context of the patient's history*—some things that look bad may not be physiologically important and may be the result of the sedation or conditions under which the examination is performed.

Or vice versa ....

Stridor is always visible.

Every bronchoscopic procedure performed in children should be recorded so that the video record can be examined again when necessary.

## Indications for Procedures

There are only two indications for bronchoscopy in children, diagnostic and therapeutic. Diagnostic bronchoscopy is indicated when there is information in the lungs or airways of the child, necessary for the care of the child, that is best obtained with a bronchoscope. Similarly, therapeutic bronchoscopy is indicated when it is the best way to achieve the necessary therapeutic goals. The specific indications for bronchoscopy will vary considerably among different institutions, as there will inevitably be wide variation in the patient populations.