

IAP Textbook of VACCINES



A Publication of Indian Academy of Pediatrics

Disclaimer

The views expressed by the authors on different vaccines and issues pertaining to immunization shall be considered as their own personal opinions. They should not be construed or cited as official stand of the Indian Academy of Pediatrics.



IAP Textbook of VACCINES

Editor-in-Chief

Vipin M Vashishtha MD FIAP

Director and Consultant Pediatrician
Mangla Hospital and Research Center
Bijnor, Uttar Pradesh, India

Editors

Rohit Agrawal MBBS DCH MD

Director, Chandrajyoti Children's Hospital, Mumbai
Consultant Pediatrician, Kohinoor Hospital
Mumbai, Maharashtra, India

TU Sukumaran MD DCH MNAMS

Professor, Department of Pediatrics
Institute of Child Health and Children Hospital
Government Medical College, Kottayam, Kerala, India

Academic Editors

Nitin K Shah MBBS MD DCH

Consultant Pediatric Hematologist
PD Hinduja National Hospital and Medical Research Center
Mumbai, Maharashtra, India

Naveen Thacker MD FIAP

Director, Deep Children Hospital and Research Center
Head, Department of Pediatrics, Sahyadri Ramkrishna Specialty Hospital
Kutch, Gujarat, India

Panna Choudhury MBBS DCH MD FIAP FIMSA FRSTMH FAMS

Consultant Pediatrician
Vice Chairman, Child Health Foundation
Executive Director, Indian Academy of Pediatrics
New Delhi, India

Vijay N Yewale MD DCH

Consultant
Dr Yewale Multispecialty Hospital for Children
Navi Mumbai, Maharashtra, India

Associate Editors

CP Bansal MD PD DAP FIAP

Director and Consultant Pediatrician
Shabd Pratap Hospital
Gwalior, Madhya Pradesh, India

A Parthasarathy MD DCH MNAMS

Senior Consultant Pediatrician, AP Child Care, Chennai
Ex Distinguished Professor, The Tamil Nadu Dr MGR Medical University
Retired Senior Clinical Professor of Pediatrics, Madras Medical College
Deputy Superintendent, Institute of Child Health and Hospital for Children
Chennai, Tamil Nadu, India

Foreword

Stanley A Plotkin



JAYPEE BROTHERS MEDICAL PUBLISHERS (P) LTD

New Delhi • London • Philadelphia • Panama



Jaypee Brothers Medical Publishers (P) Ltd

Headquarters

Jaypee Brothers Medical Publishers (P) Ltd
4838/24, Ansari Road, Daryaganj
New Delhi 110 002, India
Phone: +91-11-43574357
Fax: +91-11-43574314
Email: jaypee@jaypeebrothers.com

Overseas Offices

J.P. Medical Ltd
83 Victoria Street, London
SW1H 0HW (UK)
Phone: +44-2031708910
Fax: +02-03-0086180
Email: info@jpmedpub.com

Jaypee Medical Inc
The Bourse
111 South Independence Mall East
Suite 835, Philadelphia, PA 19106, USA
Phone: +1 267-519-9789
Email: jpmmed.us@gmail.com

Jaypee Brothers Medical Publishers (P) Ltd
Bhotahity, Kathmandu, Nepal
Phone: +977-9741283608
Email: kathmandu@jaypeebrothers.com

Website: www.jaypeebrothers.com
Website: www.jaypeedigital.com

© 2014, Editors

The views and opinions expressed in this book are solely those of the original contributor(s)/author(s) and do not necessarily represent those of editor(s) of the book.

All rights reserved. No part of this publication may be reproduced, stored or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission in writing of the publishers.

All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book.

Medical knowledge and practice change constantly. This book is designed to provide accurate, authoritative information about the subject matter in question. However, readers are advised to check the most current information available on procedures included and check information from the manufacturer of each product to be administered, to verify the recommended dose, formula, method and duration of administration, adverse effects and contraindications. It is the responsibility of the practitioner to take all appropriate safety precautions. Neither the publisher nor the author(s)/editor(s) assume any liability for any injury and/or damage to persons or property arising from or related to use of material in this book.

This book is sold on the understanding that the publisher is not engaged in providing professional medical services. If such advice or services are required, the services of a competent medical professional should be sought.

Every effort has been made where necessary to contact holders of copyright to obtain permission to reproduce copyright material. If any have been inadvertently overlooked, the publisher will be pleased to make the necessary arrangements at the first opportunity.

Inquiries for bulk sales may be solicited at: jaypee@jaypeebrothers.com

IAP Textbook of Vaccines

First Edition: 2014

ISBN: 978-93-5090-947-8

Printed at

Jaypee-Highlights Medical Publishers Inc
City of Knowledge, Bld. 237, Clayton
Panama City, Panama
Phone: +1 507-301-0496
Fax: +1 507-301-0499
Email: cservice@jphmedical.com

Jaypee Brothers Medical Publishers (P) Ltd
17/1-B Babar Road, Block-B, Shaymali
Mohammadpur, Dhaka-1207
Bangladesh
Mobile: +08801912003485
Email: jaypeedhaka@gmail.com

Dedication

This endeavor of the Academy is dedicated to:
“The children of this great country—The future of our nation”

IAP Committee on Immunization (IAPCOI), 2011-13

CHAIRPERSONS

Rohit Agrawal
TU Sukumaran

CONVENER

Vipin M Vashishtha

MEMBERS

Amarjeet Chitkara
Manjori Mitra
S Sanjay
SG Kasi
Suhas V Prabhu

ADVISORS

Nitin K Shah
Raju C Shah
Naveen Thacker
A Parthasarathy

EX-OFFICIO

Panna Choudhury (Chairman, IAPCOI, 2009-11)
Vijay N Yewale (Convener, IAPCOI, 2009-11)
Sailesh Gupta, Honorary Secretary General, IAP
Ritabrata Kundu, Chairperson, Infectious Diseases Chapter of IAP
Abhay K Shah, Secretary, Infectious Diseases Chapter of IAP

IAP Advisory Committee of Vaccines and Immunization Practices (ACVIP), 2013-14

CHAIRPERSON

CP Bansal

CO-CHAIRPERSONS

Rohit Agarwal
Vijay N Yewale

CONVENER

Vipin M Vashishtha

IAP COORDINATOR (HSG)

Sailesh Gupta

MEMBERS

Shashi Vani
Anuradha Bose
Ajay Kalra
AK Patwari
Surjit Singh

CONSULTANTS

Narendra K Arora
Naveen Thacker
Rajesh Kumar
Ajay Gambhir
VG Ramachandran
HP Sachdev

RAPPORTEUR

Panna Choudhury

Editorial Board

Editor-in-Chief



Vipin M Vashishtha MD FIAP

Director and Consultant Pediatrician
Mangla Hospital and Research Center
Bijnor, Uttar Pradesh, India

Editors



Rohit Agrawal MBBS DCH MD

Director, Chandrajyoti Children's Hospital
Mumbai
Consultant Pediatrician, Kohinoor Hospital
Mumbai, Maharashtra, India



TU Sukumaran MD DCH MNAMS

Professor
Department of Pediatrics
Institute of Child Health and Children Hospital
Government Medical College
Kottayam, Kerala, India

Academic Editors



Nitin K Shah MBBS MD DCH

Consultant Pediatric Hematologist
PD Hinduja National Hospital and
Medical Research Center
Mumbai, Maharashtra, India



Naveen Thacker MD FIAP

Director, Deep Children Hospital and
Research Center
Head, Department of Pediatrics
Sahyadri Ramkrishna Specialty Hospital
Kutch, Gujarat, India



Panna Choudhury

MBBS DCH MD FIAP FIMSA FRSTMH FAMS
Consultant Pediatrician
Vice-Chairman, Child Health Foundation
Executive Director
Indian Academy of Pediatrics
New Delhi, India



Vijay N Yewale MD DCH

Consultant
Dr Yewale Multispecialty Hospital for Children
Navi Mumbai, Maharashtra, India

Associate Editors



CP Bansal MD PD DAP FIAP

Director and Consultant Pediatrician
Shabd Pratap Hospital
Gwalior, Madhya Pradesh, India



A Parthasarathy MD DCH MNAMS

Distinguished Professor
The Tamil Nadu Dr MGR Medical University
Retired Senior Clinical Professor of Pediatrics
Madras Medical College
Deputy Superintendent
Institute of Child Health and Hospital for Children
Chennai, Tamil Nadu, India

Contributors

Anju Aggarwal MD MNAMS FIAP

Associate Professor
Department of Pediatrics
University College of Medical Sciences and GTB Hospital
New Delhi, India

Rohit Agrawal MBBS DCH MD

Director, Chandrajyoti Children's Hospital
Consultant Pediatrician, Kohinoor Hospital
Mumbai, Maharashtra, India

Shilpa Khanna Arora MBBS MD

Senior Resident
Department of Pediatrics
University College of Medical Sciences and GTB Hospital
New Delhi, India

Narendra K Arora MBBS MD DM

Executive Director
The INCLEN Trust International and CHNRI
Okhla, New Delhi, India

S Balasubramanian MD DCH FRCPC (UK) MNAMS FIA

Senior Consultant Pediatrician
Kanchi Kamakoti Childs Trust Hospital
Chennai, Tamil Nadu, India

Garima Bang MD

Senior Resident
Department of Pediatrics
University College of Medical Sciences
New Delhi, India

Till Bärnighausen MD SCD

Associate Professor of Global Health
Department of Global Health and Population
Harvard School of Public Health
Harvard University
Boston, USA

Piyali Bhattacharya MD

Consultant Pediatric Endocrinologist
Sanjay Gandhi Postgraduate Institute of Medical Sciences
Lucknow, Uttar Pradesh, India

David E Bloom BA MA PhD

Clarence James Gamble Professor of
Economics and Demography
Harvard School of Public Health
Harvard University
Boston, USA

Anuradha Bose MBBS MD DCH MRCP FRCPC

Professor
Department of Pediatrics
Christian Medical College
Vellore, Tamil Nadu, India

Shobha Broor MBBS MD

Professor and Director (Laboratory Sciences)
The INCLEN Trust International and CHNRI
Okhla, New Delhi, India

Elizabeth T Cafiero MSc (Global Health and Population)

Department of Global Health and Population
Harvard School of Public Health
Harvard University
Boston, USA

Aruna Chandran MD MPH FAAP

Chief of Epidemiologic Services
Baltimore City Health Department
Assistant Scientist
Department of Epidemiology and Pediatrics
Bloomberg School of Public Health
Baltimore, USA

Thomas Cherian MBBS DCH MD

Fellowship in Pediatric Infectious Diseases
Coordinator, Program and Impact Monitoring
Department of Immunization Vaccines and Biologicals
World Health Organization
Geneva, Switzerland

AJ Chitkara MD DNB

Head
Department of Pediatrics
Max Superspecialty Hospital
Shalimar Bagh, New Delhi, India

Panna Choudhury MBBS DCH MD FRSTMH FIMSA FIAP FAMS

Consultant Pediatrician
 Vice-Chairman, Child Health Foundation
 Executive Director, Indian Academy of Pediatrics
 New Delhi, India

Jaydeep Choudhury MBBS DNB MNAMS

Associate Professor
 Department of Pediatrics
 Institute of Child Health
 Kolkata, West Bengal, India

Aashima Dabbas MD

Assistant Professor
 Department of Pediatrics
 Vardhman Mahavir Medical College
 New Delhi, India

Pooja Dewan MD MNAMS

Assistant Professor
 Department of Pediatrics
 University College of Medical Sciences and GTB Hospital
 New Delhi, India

K Dhanalakshmi MBBS DNB

Senior Registrar and Fellow
 Infectious Diseases IAP Chapter
 Kanchi Kamakoti Childs Trust Hospital and
 Childs Trust Medical Research Foundation
 Chennai, Tamil Nadu, India

Dhanya Dharmapalan MBBS MD

Consultant Pediatrician
 Dr Yewale Multispecialty Hospital for Children
 Navi Mumbai, Maharashtra, India

AK Dutta MD

Professor and Head
 Department of Pediatrics
 Lady Hardinge Medical College
 New Delhi, India

Anil Dutta MBBS MD

Vice-President
 Clinical Research and Development and Medical Affairs
 GlaxoSmithKline Vaccines, Wavre, Belgium

MMA Faridi MD DCH MNAMS FIAP

Professor and Head
 Department of Pediatrics
 University College of Medical Sciences and GTB Hospital
 New Delhi, India

Sean Patrick Fitzwater MHS

Research Associate
 Johns Hopkins Bloomberg School of Public Health
 Department of International Health
 Baltimore, USA

Nathalie Garçon PharmD PhD

Vice-President and Head
 Global Adjuvant Center for Vaccine Development
 GlaxoSmithKline Vaccines
 Wavre, Belgium

Andrea Gay MSc (Biology and City Planning)

Executive Director of Children's Health
 United Nations Foundation
 Washington DC, USA

Canna Jagdish Ghia MBBS MD

Medical Advisor
 Pfizer Limited
 Mumbai, Maharashtra, India

Nicholas C Grassly DPhil

Professor of Vaccine Epidemiology
 Department of Infectious Disease Epidemiology
 Imperial College, London
 London, UK

Lisa A Grohskopf MD MPH

Medical Officer
 Influenza Division, Centers for Disease Control and Prevention
 Atlanta, Georgia, USA

Piyush Gupta MD FAMS FIAP

Professor, Department of Pediatrics
 University College of Medical Sciences
 New Delhi, India

Satish K Gupta MD

Health Specialist
 UNICEF India Country Office
 New Delhi, India

Alok Gupta MD FIAP

Chairperson, Environment and Child Health Group of IAP
 Jaipur, Rajasthan, India

Pramod Jog MBBS MD

Professor
 Department of Pediatrics
 DY Patil Medical College
 Pune, Maharashtra, India

T Jacob John MBBS DCH FRCP FIAP

Formerly, Professor and Head
Department of Virology
Christian Medical College
Vellore, Tamil Nadu, India

Jacob John MBBS MD

Associate Professor
Department of Community Health
Christian Medical College
Vellore, Tamil Nadu, India

Geoffrey David Kahn MSPH

Research Associate
Johns Hopkins Bloomberg School of Public Health
Department of International Health
Baltimore, USA

Ajay Kalra MD DCH MNAMS FIAP

Erstwhile Professor, SN Medical College, Agra
Head of the Department
Rural Institute of Medical Sciences, Saifai
Consultant, Child Health, Agra, Uttar Pradesh, India

Deepak Kamat MD PhD FAAP

Professor of Pediatrics
Vice-Chair of Education, Department of Pediatrics
Wayne State University, Children's Hospital of Michigan
Detroit, USA

Gagandeep Kang MD

Professor
Department of Gastrointestinal Sciences
Christian Medical College
Vellore, Tamil Nadu, India

SG Kasi MBBS DCH MD

Consultant Pediatrician
Member, IAPCOI 2011-12
Bengaluru, Karnataka, India

Satyena Katewa DCH DNB MBBS

Consultant
Pediatric Oncologist
Bone Marrow/Stem Cell Transplant
BLK Super Specialty Hospital
New Delhi, India

Amrit Koirala BSc Medical Laboratory Technology (Pursuing MSc Medical Microbiology)

Student, Christian Medical College
Vellore, Tamil Nadu, India

Puneet Kumar MBBS MIAP

Consultant
Kumar Child Clinic
Dwarka, New Delhi, India

Ritabrata Kundu MD

Professor, Department of Pediatric Medicine
Institute of Child Health
Kolkata, West Bengal, India

Kathryn E Lafond MPH

Influenza Division
Centers for Disease Control and Prevention
Atlanta, Georgia, USA

Chandrakant Lahariya MD DNB MNAMS PGDHHM

Formerly, Assistant Professor
Department of Community Medicine
GR Medical College
Gwalior, Madhya Pradesh, India

Renu B Lal MD

Influenza Division, National Center for Immunization and
Respiratory Diseases
Centers for Disease Control and Prevention
Atlanta, Georgia, USA

Mukta Mantan

Professor, Department of Pediatrics
Maulana Azad Medical College
New Delhi, India

Ambika Mathur MD PhD

Program Director, Interim Dean
Graduate School, Wayne State University
Detroit, USA

Premasish Mazumdar MBBS MD DM (Neonatology)

Specialist, Premature and Newborn Diseases
Amit Jaggi Memorial Hospital
Agra, Uttar Pradesh, India

Parang N Mehta MD

Consultant Pediatrician
Mehta Hospital
Surat, Gujarat, India

Pravin J Mehta MD DCH

Consulting Pediatrician
Jack-N-Jill Nursing Home and Hindusabha Hospital
Mumbai, Maharashtra, India

Lalitha Mendis MBBS (Cey) MD (Col) PhD (Lond) Dp Bact (Manch) F
Nat Acad Sciences SL Hon Fell CGP-SL

Emeritus Professor
Department of Microbiology
University of Colombo
Colombo, Sri Lanka

Geeta MG MD

Additional Professor
Department of Pediatrics
Government Medical College
Kozhikode, Kerala, India

Saheli Misra MBBS MRCP (UK) DNB

Assistant Professor
Institute of Child Health
Kolkata, West Bengal, India

Monjori Mitra DCH DNB

Associate Professor
Institute of Child Health
Kolkata, West Bengal, India

Archisman Mohapatra MBBS MD

Resident
Department of Community Medicine, IMS (BHU)
Varanasi, Uttar Pradesh, India

Sally Mossman PhD

Head of Viral Vaccine Program
GlaxoSmithKline Biologicals
Rixensart, Belgium

PV Murthy DCH MD

Consultant Pediatrician
Venturi Clinic, Bengaluru, Karnataka, India

Pritesh Nagar MBBS MD

Academic Coordinator and In-Charge ICUS
Department of Pediatrics
Aditya Hospital, Hyderabad, Andhra Pradesh, India

Christopher Nelson MD

Director, Coalition against Typhoid Secretariat
Sabin Vaccine Institute
Washington DC, USA

Jennifer Carroll O'Brien MD MPH

Associate Professor
University of Rochester Medical Center
Brown Square Health Center
Rochester, New York, USA

R Leon Ochiai DPhil MHS

Research Scientist
International Vaccine Institute
Seoul, South Korea

Sameer Parekh BHMS MBA

Manager, Medical Affairs and Clinical Trials
Serum Institute of India Ltd
Pune, Maharashtra, India

A Parthasarathy MD DCH MNAMS

Distinguished Professor
The Tamil Nadu Dr MGR Medical University
Retired Senior Clinical Professor of Pediatrics
Madras Medical College
Deputy Superintendent
Institute of Child Health and Hospital for Children
Chennai, Tamil Nadu, India

Alberta Di Pasquale PhD (Vaccinology)

Director, Early Projects Global Medical Affairs
GlaxoSmithKline Biologicals
London, UK

Yash Paul MBBS DCH

Consultant Pediatrician
Maharaja Agrasen Hospital
Jaipur, Rajasthan, India

Harish K Pemde MD

Professor, Department of Pediatrics
Lady Hardinge Medical College
Kalawati Saran Children's Hospital
New Delhi, India

VG Ramachandran MBBS MD

Professor, Department of Microbiology
University College of Medical Sciences and GTB Hospital
New Delhi, India

Gautam Rambhad MD

Associate Director
Medical Services
Wyeth Limited
Mumbai, Maharashtra, India

Amit Rawat MD (Pathology) PDCC (Laboratory Immunology)

Assistant Professor
Department of Pediatric Allergy and Immunology
Advanced Pediatric Center
Postgraduate Institute of Medical Education and Research
Chandigarh, India

Anupam Sachdeva MD

Consultant Pediatrician and Director
Pediatric Hematology and
Bone Marrow Transplantation
Sir Ganga Ram Hospital
New Delhi, India

Siddhartha Saha MD

Public Health Specialist
India Influenza Center
Centers for Disease Control and Prevention
Atlanta, Georgia, USA

Sushant Sahastrabudhe MBBS MPH

Associate Research Scientist
International Vaccine Institute
Seoul, South Korea

Mathuram Santosham MD MPH

Professor
Director, Health Systems Program
Director, Center for American Indian Health
Professor, International Health and Pediatrics
Johns Hopkins University
Baltimore, USA

Nitin K Shah MBBS MD DCH

Consultant Pediatric Hematologist
PD Hinduja National Hospital and
Medical Research Center
Mumbai, Maharashtra, India

Raju C Shah MD FIAP

Professor and Head
Department of Pediatrics
GCS Medical College
Ahmedabad, Gujarat, India

Pratima Shah MBBS MD

Former Professor
Department of Pediatrics
SBKS Medical College
Ankur Institute of Child Health
Ahmedabad, Gujarat, India

**Abhay K Shah MBBS (Gold Medalist)
DPED (UNI First) MD (Gold Medalist)**

Director
Dr Abhay K Shah Children Hospital
Honorary Secretary, ID Chapter of IAP
President, IAP Gujarat
Ahmedabad, Gujarat, India

Arun Shah MD DCH FIAP FIAMS

Consultant Pediatrician
Brahampura
Muzaffarpur, Bihar, India

Himani Shah MBBS MD FCPS

Consultant Pediatrician
Chandrayoti Hospital
Mumbai, Maharashtra, India

Hitt Sharma MBBS PGDCT PDCR

Additional Director
Department of Medical Affairs and
Clinical Trials
Serum Institute of India Ltd
Pune, Maharashtra, India

Sangeeta Sharma MBBS MD (Pharmacology)

Head
Department of Pediatrics
National Institute of TB and Respiratory Diseases
Member Secretary, National Technical Working Group of
Pediatric TB
Ministry of Health and Family Welfare
Government of India
New Delhi, India

Digant D Shastri MD FIAP PGDHHM

Chief Consultant Pediatrician and CEO
Killol Children Hospital
NICU and Vaccination Center
Surat, Gujarat, India

Surjit Singh MD DCH (Lon) FRCP (Lon) FRCPCH (Lon) FIAP FAMS

Professor of Pediatrics and Chief
Pediatric Allergy and Immunology Unit
Advanced Pediatric Center
Postgraduate Institute of Medical Education and Research
Chandigarh, India

Tanu Singhal MSc (Tropical Medicine & International Health) MD

Consultant
Pediatrics and Infectious Disease
Kokilaben Dhirubhai Ambani Hospital and
Medical Research Institute
Mumbai, Maharashtra, India

Sanjay Srirampur MD

Head, Department of Pediatrics
Aditya Hospital
Hyderabad, Andhra Pradesh, India

Kamath SS MBBS DCH MD

Medical Director and Consultant Pediatrician
Welcare Hospital
Kochi, Kerala, India

Wayne Sullender MD

Visiting Professor
Childrens Hospital
Birmingham, Alabama, USA

A Sumanth MBBS DCH DNB

Senior Registrar, Department of Pediatrics
Kanchi Kamakoti Childs Trust Hospital and the Childs Trust
Medical Research Foundation
Chennai, Tamil Nadu, India

Fernanda Tavares MD

Director
Therapeutic Area Head
GlaxoSmithKline vaccines
Wavre Nord, Wavre, Belgium

Naveen Thacker MD FIAP

Director, Deep Children Hospital and Research Center
Head, Department of Pediatrics
Sahyadri Ramkrishna Specialty Hospital
Kutch, Gujarat, India

Satish Kamtaprasad Tiwari MD LLB FIAP IBCLC

Professor and Head
Department of Pediatrics
Dr Panjabrao Deshmukh Memorial Medical College, Amravati
Founder President
Indian Medicolegal and Ethics Association
Amaravati, Maharashtra, India

Jeerson C Unni MD DCH FIAP

Consultant Pediatrician
Dr Kunhalu's Nursing Home
Cochin, Kerala, India

Shashi N Vani MBBS MD FIAP

Emeritus Professor
Department of Pediatrics

PS Medical College, Karamsad, Gujarat
Retired Professor and Head
Department of Pediatrics and Neonatology
BJ Medical College
Ahmedabad, Gujarat, India

Vipin M Vashishtha MD FIAP

Director and Consultant Pediatrician
Mangla Hospital and Research Center
Bijnor, Uttar Pradesh, India

Jignesh Ved MBBS MD PGDMM

Senior Medical Advisor
Pfizer India Limited
Mumbai, Maharashtra, India

Sanjay Verma MD

Assistant Professor, Department of Pediatrics
Advanced Pediatric Center
Postgraduate Institute of Medical Education and Research
Chandigarh, India

Marc-Alain Widdowson MD

National Center for Immunizations and Respiratory Disease
Centers for Disease Control and Prevention
Atlanta, Georgia, USA

Sangeeta Yadav MD FIAP

Director Professor
Department of Pediatrics
Maulana Azad Medical College and Associated Hospitals
University of Delhi
New Delhi, India

Vijay N Yewale MD DCH

Consultant
Dr Yewale Multispecialty Hospital for Children
Navi Mumbai, Maharashtra, India

Rajeev Zachariah MD DCH

Well Baby Clinic
Department of Child Health
Christian Medical College
Vellore, Tamil Nadu, India

Foreword

Diseases preventable by vaccination are disappearing all over the world as vaccine coverage increases. Certain infectious diseases have been essentially eliminated from the Americas, and although Europe is lagging behind in some respects, even there, epidemics of diseases, for which we have vaccines are unusual. That is not to say that the picture is completely rosy. Failure to vaccinate is a problem in isolated populations and some of our vaccines do not give high efficacy, owing to poor immune responses in particular patient groups or incomplete knowledge about the correlates of protection.

India and neighboring countries have presented special problems. Until recently, governmental interest in the introduction of new vaccines has been limited, perhaps because of a focus on polio eradication. In addition, the vast number of potential vaccinees does not make either routine or campaign distribution easy. Fortunately, the situation is changing for several reasons: the growing interest of physicians, the manifest importance of Asian vaccine manufacturers, and a greater understanding by governments that vaccination carries economic as well as health benefits.

Like politics, all vaccination must be local. Although the sixth edition of an international vaccine textbook, which I had the honor to edit, was published last year (*Vaccines*, Elsevier), disease epidemiology, vaccine schedules, medical practice, and vaccine administration differ according to local practices. Thus, a book that focuses on vaccination in Asia, where the majority of the world's population lives will serve an important purpose, and I hope it will be read widely throughout this huge geographical area. Moreover, Asian physicians and scientists should contribute even more to the body of knowledge concerning vaccination in all its aspects, from basic immunology to vaccine development and clinical trials. In that way, vaccine science will grow and benefit people in all corners of the world.



Stanley A Plotkin MD

Emeritus Professor of Pediatrics, University of Pennsylvania
Emeritus Professor, Wistar Institute
Adjunct Professor, Johns Hopkins University
Pennsylvania, USA

From the Desk of IAP President, 2013

Indian Academy of Pediatrics (IAP) has always accorded a very high priority to the various issues related to pediatric immunization in the country—be it framing recommendations for practicing fraternity or issuing guidelines on the need of inclusion of a particular vaccine in the national immunization schedule or training of program managers involved with delivery of vaccines in the field. The Academy has also played a proactive role in taking on misinformation campaign against vaccines in media. We, as an academic body, have contributed a lot in the success of Global Polio Eradication Initiative in the country, and now giving technical support to the ongoing Measles and Rubella Elimination Initiative. In fact, the Academy has never shrugged off its responsibility of a serious civil society organization, committed to the wellbeing of the children of this country. The amount of significance accorded to immunization can be gauged by the fact that a separate subcommittee of the Academy, now rechristened as Advisory Committee of Vaccines and Immunization Practices (ACVIP), has been purposely constituted to deal with all the issues related to the practice of immunization in the country for last many years.



The Academy is regularly publishing its recommendations on licensed vaccines and other aspects related to the pediatric immunization in the form of a compact booklet, *IAP Guidebook on Immunization*. This book is one of the most sought after publications of the Academy. Not only the practicing pediatricians, but even the vaccine manufacturers and policy makers cite the recommendations contained in the book. However, the need of a comprehensive book on the contemporary Indian scenario of vaccine-preventable diseases, vaccines, and practice of vaccination was felt for quite some time. As Chair of the ACPVIP, and also as President of the Academy in this Golden Jubilee year, I think this book is a perfect gift by the committee to all the stakeholders involved in the field of immunization in the country and abroad. I am pretty sure that this venture shall fulfill the great void in our understanding of vaccine sciences and would serve as a reference material to all concerned. In the last, I congratulate all the contributors from the country and abroad, and the editors who have worked very hard to bring out this precious publication.

CP Bansal MD PD DAP FIAP
President, Indian Academy of Pediatrics, 2013
Director and Consultant Pediatrician
Shabd Pratap Hospital
Gwalior, Madhya Pradesh, India

Preface

There seems no exaggeration in William Foege's words when he uttered, "Vaccines are the tugboats of preventive health". Apart from sanitation and safe water, no other intervention seems as powerful as vaccination in providing insulation to humankind from dreadful diseases. Vaccination has been so effective in taking on some of the formidable diseases that people became complacent about vaccine-preventable diseases (VPDs) in many developed countries. It is kind of "out-of-sight, out-of-mind" situation for many VPDs owing to effective vaccination as quite eloquently described by David Neumann. Yet, this phrase is applicable only for the children residing in less than half of the globe. For majority living in far more hostile and challenging conditions of the third world, the VPDs are still very much on the horizon. In fact, the children of the less developed countries need the umbrella of modern vaccination much more than their counterparts of developed world. The full potential of modern-day vaccines in making humankind disease-free, cannot be exploited until they are employed in the regions of the globe where their needs are felt the most.

The need of the vaccines is felt the most in India, which accounts for 20% of the world's child population, and responsible for 24% of all under-five deaths globally. India has been using vaccines since late 70s in its National Immunization Program (NIP) and currently running one of the largest mass immunization programs in the world. However, the performance of the overall program in many fields is still far from satisfactory. Coverage of many traditional vaccines remains disconcertingly low and many new vaccines that protect against today's some of the greatest threats to children, including pneumococcal disease and rotavirus have yet to be introduced into NIP. There are many barriers to achieve desired results; paucity of trained health professionals and workers in the field of vaccination is one of them. Furthermore, there is scarcity of good quality training and reliable resources in the field of vaccinology in the country.

Resistance to vaccination is almost as old as Jenner's smallpox vaccine. Misinformation campaigns against vaccine's safety may be detrimental to a well-established vaccination program of any nation. However, it may prove to be fatal to a developing country's ongoing vaccination initiatives as experienced in India in recent times. This phenomenon is growing worldwide and needs to be tackled with deft risk communication. One must not forget James Shannon's words, "The only safe vaccine is a vaccine that is never used."

The Indian Academy of Pediatrics has been at the forefront of advocacy and training pertaining to vaccination, particularly in the private sector of the country. It has been periodically issuing its recommendations for both public and private health care sectors in the form of bundled guidelines contained in a 'Guidebook of Immunization'. However, the need of a publication containing detailed region-specific information on the epidemiology of VPDs and vaccines has been felt for quite long. This endeavor of the Academy in the form of a comprehensive textbook on vaccines must be viewed as an attempt to fill this void.

The first edition of the book is in your hands for your perusal. It covers almost all the aspects related to modern vaccinology including currently available licensed vaccines and general aspects of immunization. Sections are also devoted to vaccines in the pipeline along with newer vaccine techniques. A separate section of the book deals with issues related to vaccine policies, trials, ethics and regulatory needs.

The book shall provide in-depth information to the professionals working in the field of vaccination in India and neighboring South-Central and South-Eastern Asian countries. Special emphasis is provided to disease epidemiology and vaccine needs of India and neighboring countries. This publication should also serve as a reference material for international health agencies, government health establishments, vaccine developers, immunization program managers, and vaccine funding agencies. At the same time, the book should also be of great utility to postgraduate students, faculty members of medical institutions, and practicing pediatricians of the country.

A galaxy of national and international experts in the field of immunization has contributed enthusiastically to this project. We are grateful to all of them for sparing their invaluable time for the book and sharing their vast expertise in the respective fields of immunization. We apologize for irksome requests and ultimatums, if any in order to meet the deadline. We do sincerely hope this edition will be considered as a useful resource in the field for all those who recognize the need and the value of vaccines in the arena of child health.

Vipin M Vashishtha
Rohit Agrawal
TU Sukumaran
Nitin K Shah
Naveen Thacker
Panna Choudhury
Vijay N Yewale
CP Bansal
A Parthasarathy

Acknowledgments

The editors are highly thankful to the dedicated team of publishers, particularly Dr Neeraj Choudhary and Ms Madhvi Thakur for their untiring efforts that culminated in publication of this book in time. The assistance provided by Dr Ajay Kalra and Dr Chandrakant Lahariya in reviewing many manuscripts is also thankfully acknowledged.

Contents

SECTION 1: GENERAL ASPECTS OF VACCINATION

■ Chapter 1: History of Vaccines	3
<i>A Parthasarathy, Hitt Sharma, Sameer Parekh</i>	
■ Chapter 2: Vaccination in India: Past, Present, and Future	9
<i>Chandrakant Lahariya</i>	
■ Chapter 3: Vaccine Immunology	25
<i>Deepak Kamat, Ambika Mathur</i>	
■ Chapter 4: Immunological Correlates of Protection Induced by Vaccines	37
<i>Amit Rawat, Surjit Singh</i>	
■ Chapter 5: Epidemiology in Relation to Vaccinology	43
<i>Shilpa Khanna Arora, Piyush Gupta</i>	
■ Chapter 6: General Recommendations on Immunization	52
<i>Tanu Singhal</i>	
■ Chapter 7: Scheduling of Vaccines	57
<i>Panna Choudhury, Garima Bang</i>	
■ Chapter 8: Mucosal Immunology and Vaccination	64
<i>Monjori Mitra</i>	
■ Chapter 9: Mucosal Immunity to Poliovirus	68
<i>Nicholas C Grassly</i>	
■ Chapter 10: Herd Immunity and Herd Protection: Benefits and Harms to Community by Vaccines	74
<i>Yash Paul</i>	
■ Chapter 11: Adverse Events Following Immunization	79
<i>Ajay Kalra, Premasish Mazumdar</i>	
■ Chapter 12: Cold Chain and Vaccine Storage	89
<i>Satish K Gupta, Digant D Shastri</i>	
■ Chapter 13: Vaccine Safety and Misinformation about Vaccination	100
<i>Anuradha Bose</i>	
■ Chapter 14: Disease Elimination and Eradication	110
<i>Alok Gupta</i>	
■ Chapter 15: Adjuvants	121
<i>Nathalie Garçon, Alberta Di Pasquale, Fernanda Tavares</i>	

SECTION 2: LICENSED VACCINES

■ Chapter 16: Tuberculosis Vaccines	139
<i>Sangeeta Sharma</i>	
■ Chapter 17: Inactivated Poliovirus Vaccine	146
<i>T Jacob John, Amrit Koirala</i>	
■ Chapter 18: Poliovirus Vaccine—Live	154
<i>T Jacob John, Amrit Koirala</i>	
■ Chapter 19: Hepatitis B Vaccine	163
<i>Ajay Kalra</i>	
■ Chapter 20: Diphtheria	174
<i>Shashi N Vani</i>	
■ Chapter 21: Tetanus	183
<i>Shashi N Vani</i>	
■ Chapter 22: Pertussis Vaccines	194
<i>Vipin M Vashishtha</i>	
■ Chapter 23: Diphtheria, Pertussis and Tetanus Vaccines	214
<i>AJ Chitkara</i>	
■ Chapter 24: <i>Haemophilus influenzae</i> Type B Vaccines	222
<i>Geoffrey David Kahn, Sean Patrick Fitzwater, Aruna Chandran, Mathuram Santosham</i>	
■ Chapter 25: Pneumococcal Vaccines	240
<i>Thomas Cherian</i>	
■ Chapter 26: Rotavirus Vaccines	249
<i>Rajeev Zachariah, Gagandeep Kang</i>	
■ Chapter 27: Measles Vaccines	265
<i>Sangeeta Yadav, Mukta Mantan</i>	
■ Chapter 28: Rubella Vaccine	273
<i>Sangeeta Yadav, Aashima Dabbas</i>	
■ Chapter 29: Measles and Rubella Initiative	279
<i>Andrea Gay, Naveen Thacker</i>	
■ Chapter 30: Mumps	284
<i>Sangeeta Yadav</i>	
■ Chapter 31: Hepatitis A Vaccines	290
<i>Nitin K Shah</i>	
■ Chapter 32: Typhoid Fever Vaccines	304
<i>Sushant Sahastrabudde, Christopher B Nelson, R Leon Ochiai</i>	
■ Chapter 33: Varicella Zoster Vaccine	323
<i>Raju C Shah, Pratima Shah</i>	
■ Chapter 34: Human Papillomavirus Vaccine	334
<i>Saheli Misra, Ritabrata Kundu</i>	
■ Chapter 35: Seasonal and Pandemic Influenza Vaccines	341
<i>Renu B Lal, Kathryn E Lafond, Siddhartha Saha, Wayne Sullender, Lisa A Grohskopf, Marc-Alain Widdowson, Shobha Broor</i>	

■ Chapter 36: Meningococcal Vaccine	357
<i>MMA Faridi, Pooja Dewan</i>	
■ Chapter 37: Japanese Encephalitis Vaccines	364
<i>Anju Aggarwal</i>	
■ Chapter 38: Rabies Vaccine	375
<i>Jaydeep Choudhury</i>	
■ Chapter 39: Cholera Vaccine	382
<i>Monjori Mitra</i>	
■ Chapter 40: Yellow Fever Vaccine	386
<i>Parang N Mehta</i>	
■ Chapter 41: Combination Vaccines	392
<i>AK Dutta, Harish K Pemde</i>	
SECTION 3: VACCINES IN DEVELOPMENT, NEW VACCINE STRATEGIES AND VACCINES IN THE PIPELINE	
■ Chapter 42: Therapeutic Vaccines	401
<i>SG Kasi, VP Murthy</i>	
■ Chapter 43: Enterovirus Vaccines (Especially EV71)	411
<i>Piyali Bhattacharya</i>	
■ Chapter 44: Vaccines against Dengue	417
<i>Ajay Kalra, Sanjay Verma</i>	
■ Chapter 45: Diarrheal Disease Vaccines	421
<i>S Balasubramanian, K Dhanalakshmi, A Sumanth</i>	
■ Chapter 46: Epstein-Barr Virus Vaccines	433
<i>VG Ramachandran</i>	
■ Chapter 47: Hepatitis C Vaccine	439
<i>Abhay K Shah</i>	
■ Chapter 48: Hepatitis E—An Overview and Recent Advances in Vaccine Research	448
<i>Arun Shah</i>	
■ Chapter 49: Human Immunodeficiency Virus Vaccine	454
<i>Rohit Agrawal, Himani Shah</i>	
■ Chapter 50: Malaria Vaccines	460
<i>Sanjay Srirampur, Pritesh Nagar</i>	
■ Chapter 51: Chikungunya Vaccine	468
<i>Kamath SS, Geeta MG</i>	
■ Chapter 52: Respiratory Syncytial Virus Vaccines and Parainfluenza Virus Vaccines	472
<i>Dhanya Dharmapalan, Vijay N Yewale</i>	
■ Chapter 53: New Technologies for Vaccine Development	475
<i>Anil Dutta, Nathalie Garçon, Sally Mossman</i>	
■ Chapter 54: Alternative Vaccine Delivery Methods	484
<i>Puneet Kumar</i>	

SECTION 4: VACCINATION OF SPECIAL GROUPS

■ Chapter 55: Immunization in Special Situations	501
<i>Rohit Agrawal, Himani Shah</i>	
■ Chapter 56: Vaccination in Immunocompromised Children	507
<i>Satyendra Katewa, Anupam Sachdeva</i>	
■ Chapter 57: Adolescent Immunization	516
<i>A Parthasarathy, Hitt Sharma, Sameer Parekh</i>	
■ Chapter 58: Vaccination Strategies for Travelers	521
<i>Digant D Shastri</i>	

SECTION 5: VACCINE POLICIES, TRIALS AND REGULATORY ISSUES

■ Chapter 59: National Vaccine Policy of India	531
<i>Vipin M Vashishtha</i>	
■ Chapter 60: Vaccine Industry and Manufacturing of Vaccines	541
<i>Gautam Rambhad, Jignesh Ved, Canna Jagdish Ghia</i>	
■ Chapter 61: Issues Relating to Immunization in Developing Countries	548
<i>Lalitha Mendis</i>	
■ Chapter 62: Introduction of a New Vaccine into an Immunization Program	556
<i>Jacob John, Gagandeep Kang</i>	
■ Chapter 63: New Thinking on the Value of Vaccination—Globally and in India	563
<i>Till Bärnighausen, David E Bloom, Elizabeth T Cafiero, Jennifer Carroll O'Brien</i>	
■ Chapter 64: Role of National Technical Advisory Group for Immunization and National Regulatory Authority in Vaccination Programs and Practices	572
<i>Archisman Mohapatra, Narendra K Arora</i>	
■ Chapter 65: Prioritizing Vaccines in Private Sector	585
<i>Pramod Jog</i>	
■ Chapter 66: Legal Issues in Immunization	588
<i>Satish Kamtaprasad Tiwari</i>	
■ Chapter 67: Ethical Issues in Immunization	595
<i>Yash Paul, Satish Kamtaprasad Tiwari</i>	
■ Chapter 68: Marketing of Vaccines and Healthcare Professionals	599
<i>Pravin J Mehta</i>	
■ Chapter 69: Web Sites Containing Reliable Information Regarding Immunization	602
<i>Jeelson C Unni</i>	
■ Appendices	
1. National Immunization Schedule for Infants, Children and Pregnant Women	609
2. IAP Immunization Timetable 2013	610
3. IAP Recommended Immunization Schedule for Children Aged 0-18 Years (With Range), 2013	612
■ Index	619