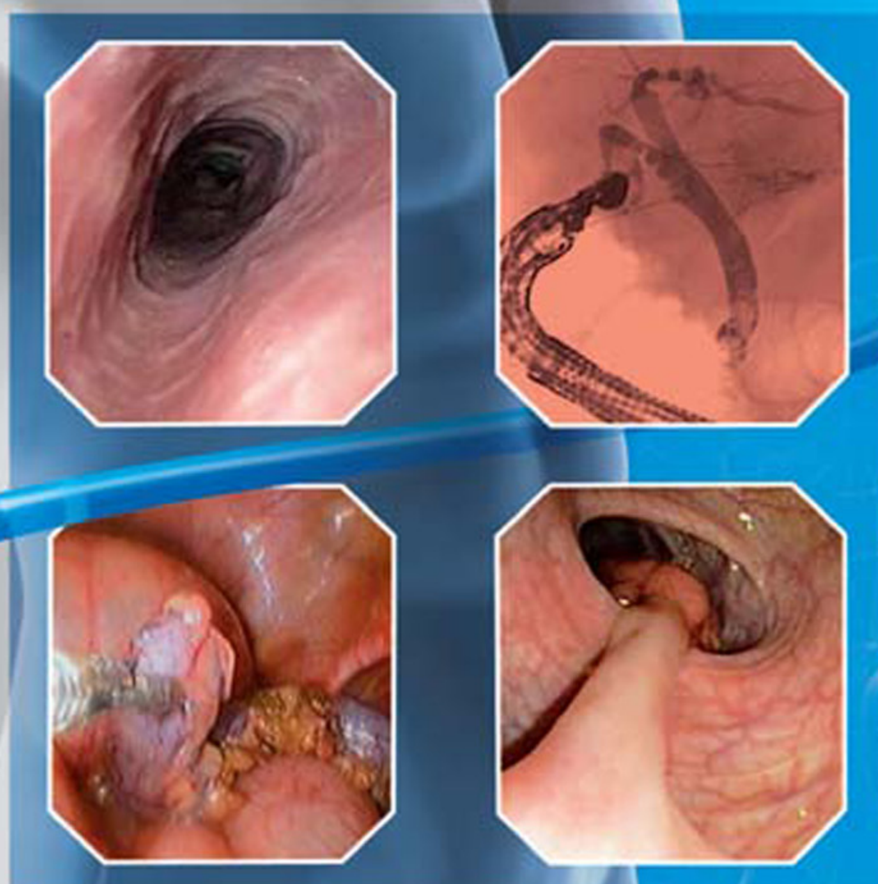
Gastroenterological Endoscopy

Meinhard Classen
Guido N. J. Tytgat
Charles J. Lightdale

Second Edition



Thieme

Thieme

Gastroenterological Endoscopy

Meinhard Classen, MD
Professor Emeritus and former Chairman
Department of Internal Medicine
Technical University of Munich
Munich, Germany

Guido N. J. Tytgat, MD, PhD
Professor Emeritus of Gastroenterology
University of Amsterdam
Former Chief of Department of Gastroenterology
Academic Medical Center
Amsterdam, the Netherlands

Charles J. Lightdale, MD
Professor of Clinical Medicine and
Director of Clinical Research
Division of Digestive and Liver Diseases
New York Presbyterian Hospital / Columbia University
Medical Center
New York, USA

Associate Editors
Jacques J. G. J. M. Bergman, Alexander Meining,
D. Nageshwar Reddy, Michael B. Wallace, Hisao Tajiri

Second edition

With contributions by

Douglas G. Adler, Furqaan Ahmed, Hans-Dieter Allescher, Anthony T. R. Axon, Rami J. Badreddine, John Baillie, Juergen Barnert, Todd H. Baron, Hugh Barr, J. F. W. M. Bartelsman, Witold Bartnik, Vikram Bhatia, David Bjorkman, Wojciech Blonski, Lawrence J. Brandt, Marco J. Bruno, Andrew K. Burroughs, David Cave, Jean Pierre Charton, Evangelos Cholongitas, Meinhard Classen, Guido Costamagna, Stefan von Delius, Michel Delvaux, James A. DiSario, Steven A. Edmundowicz, Axel Eickhoff, Shungo Endo, Pietro Familiari, Paul Feuerstadt, Hubertus Feußner, David E. Fleischer, Evan L. Fogel, Victor L. Fox, Gérard Gay, Karel Geboes, Joseph E. Geenen, Nalini M. Guda, Neil Gupta, Gregory B. Haber, Robert H. Hawes, Juergen Hochberger, Keiichi Ikeda, John M. Inadomi, Sreeni Jonnalagadda, Michael Jung, Abdel Meguid Kassem, Ralf Kiesslich, Kiyonori Kobayashi, David Kotlyar, Richard A. Kozarek, Shin-ei Kudo, Spiros D. Ladas, James Y. W. Lau, Glen A. Lehman, Blair S. Lewis, Gary R. Lichtenstein, Jenifer R. Lightdale, Juergen Maiss, Elisabeth M. H. Mathus-Vliegen, Koji Matsuda, Kai Matthes, Helmut Messmann, Hideyuki Miyachi, Faris M. Murad, Horst Neuhaus, H. Juergen Nord, Hiroyuki Ono, Jacek Pachlewski, Sandy H. Y. Pang, Shabana F. Pasha, Andrew T. Pellecchia, Jan-Werner Poley, Thierry Ponchon, Jeffrey L. Ponsky, Benjamin K. Poulose, Christian Prinz, D. Nageshwar Reddy, Jaroslaw Regula, Jürgen F. Riemann, Gurpal S. Sandha, Yasushi Sano, Shiv Kumar Sarin, Brian Saunders, Stefan Seewald, Marco Senzolo, Prateek Sharma, Stuart Sherman, Chan-Sup Shim, Nathan J. Shores, Nib Soehendra, Ma Somsouk, Joseph J. Y. Sung, Paul Swain, Hisao Tajiri, Shinji Tanaka, George Triadafilopoulos, Andrea Tringali, K. M. A. J. Tytgat, Guido N. J. Tytgat, Kenneth K. Wang, Jerome D. Waye, Justin C.Y. Wu, Byung Moo Yoo

1820 illustrations

Thieme
Stuttgart · New York

Library of Congress Cataloging-in-Publication Data is available from the publisher.

Important note: Medicine is an ever-changing science undergoing continual development. Research and clinical experience are continually expanding our knowledge, in particular our knowledge of proper treatment and drug therapy. Insofar as this book mentions any dosage or application, readers may rest assured that the authors, editors, and publishers have made every effort to ensure that such references are in accordance with **the state of knowledge at the time of production of the book.**
Nevertheless, this does not involve, imply, or express any guarantee or responsibility on the part of the publishers in respect to any dosage instructions and forms of applications stated in the book. **Every user is requested to examine carefully** the manufacturers' leaflets accompanying each drug and to check, if necessary in consultation with a physician or specialist, whether the dosage schedules mentioned therein or the contraindications stated by the manufacturers differ from the statements made in the present book. Such examination is particularly important with drugs that are either rarely used or have been newly released on the market. Every dosage schedule or every form of application used is entirely at the user's own risk and responsibility. The authors and publishers request every user to report to the publishers any discrepancies or inaccuracies noticed. If errors in this work are found after publication, errata will be posted at www.thieme.com on the product description page.

Rüdigerstrasse 14, 70 469 Stuttgart, Germany
http://www.thieme.de
Thieme New York, 333 Seventh Avenue,
New York, NY 10 001, USA
http://www.thieme.com

Cover design: Thieme Publishing Group
Typesetting by primustype Hurler, Notzingen, Germany
Printed in China by Leo Paper Ltd, Hongkong
ISBN 978-3-13-125852-6 1 2 3 4 5 6

Preface

Seven years after the initial publication of our book we now present the second edition. This new edition employs the same proven concept as before. However, its content fully reflects the rapid advances that have characterized the development of gastroenterological endoscopy in recent years. This development is not solely the result of technical progress but has also been driven by an increasing interest in endoscopy of the gastrointestinal tract. It is evident that the number of endoscopic centers has continuously increased in recent years. We note with some satisfaction that this development has embraced every continent. The major endoscopic journals report both increasing subscriptions and increasing submissions of scientific papers. The major emerging economic powers in Asia, such as China and India, have apparently decisively influenced this development. We also note that scientific papers in the field of endoscopy no longer come exclusively from university hospitals, but increasingly from municipal hospitals and private practices as well.

This newly acquired knowledge extends to all aspects of gastroenterological endoscopy that are relevant to the patient: patient preparation prior to examination, premedication, screening of premalignant and malignant lesions, endoscopic diagnosis, and therapy.

Completely new technology and methods have been introduced. Not only has the endoscopist's field of endeavor expanded continuously as a result of this development, it has also undergone significant change.

The magic acronym NOTES has evoked fascination. It refers to transluminal invasive procedures in which the endoscope is advanced through the wall of the organ of approach (stomach, vagina, etc.) to reach the target organ in the abdominal or retroperitoneal space in order to remove the appendix, gallbladder, kidney, etc. Surgical teams that include gastroenterologists now see a completely new field of endeavor unfolding for the intrepid gastroenterological endoscopist.

Colorectal carcinoma is by far the most impressive example of the impact of health care policies on the field of endoscopy. Where colonoscopy is the established method of screening for colon cancer, as in the United States and many European countries, endoscopists are veritably flooded with screenees. Might this not mean that other equally important tasks of the physician are being neglected as a result? Obviously new biomarkers for colon cancer with high sensitivity and specificity are needed to filter out unsuitable candidates so that only those cases where a genuine suspicion exists are sent to colonoscopy.

Naturally, colonoscopy and the removal of adenomas are indispensable established methods of colon cancer screening. However, not every intervention detects precancerous lesions or small malignancies, permitting timely endoscopic or surgical removal. Obviously improvements to endoscopic methodology or completely new methods are required to reduce the number of interval carcinomas to near zero.

Recent findings that flat and dimpled adenomas and certain serrated polyps in the colon entail a higher risk of malignant degeneration are important. Here there is some good news. Clear improvements in the detection of changes in the epithelial surface of the gastrointestinal tract have resulted from enlarging the endoscopic image, using dyes, autofluorescence, high-definition endoscopy, and also by manipulating the wavelength of the applied light by means of narrow-band imaging (NBI) and Fujinon intelligent color enhancement (FICE). More precise evaluation of the substrate also permits endoscopic classification of changes as premalignant or malignant lesions; the Paris–Japan and Kudo classifications are convincing examples of such a system. But this is not all. With the aid of confocal laser microscopy it is possible to obtain images of the deeper layer of the intestinal mucosa beneath the epithelial surface. This modality can visualize high-grade dysplasia in ulcerative colitis that might go undetected with white light microscopy. Have we not come very close to many older endoscopists' dream of practicable "endoscopic histology"?

The endoscopic submucosal dissection (ESD) developed by our Japanese friends represents a great advance in both diagnosis and therapy. In contrast to endoscopic mucosal resection (EMR), ESD allows better en bloc resection of the tumor-bearing area of the wall, more precise histopathological diagnostic studies, and a deeper resection. In the first edition of our book we had described endoscopic mucosal resection as a revolutionary advance. Now this elegant method risks being supplanted by endoscopic submucosal dissection. This will hold true especially if the modification suggested by the American Apollo group, namely first marking the affected area of the wall laterally with electrocautery and lifting the wall by inflating a balloon in the submucosa, does indeed increase safety and reduce the time required for surgery.

New imaging modalities such as high-resolution–high-magnification endoscopy, autofluorescence, spectra modulation, etc., and new therapeutic technology were applied in the colon. This novel technology was also applied in other fields such as esophagus, stomach, and bilio-pancreatic area. Particularly Barrett's esophagus was favored to apply and evaluate all novel technology but progress in diagnostic and therapeutic possibilities was also made in the bilio-pancreatic field.

A true novelty in this second edition of the atlas is the in depth description of investigational possibilities for small intestinal diseases with capsule endoscopy and mono- and double balloon endoscopy. The last endoscopic frontier has now been tackled, allowing investigation of the entire intestinal tract, whenever clinically indicated.

In parallel with the amazing endoscopic evolution was the further development of diagnostic and particularly therapeutic endosonography. Something which was unthinkable in the past is now entering the arena of routine procedures in an optimally equipped and skilled endoscopic unit.

The key contributions of the gastroenterologal endoscopist to digestive oncology are hardly at risk of being usurped by other disciplines. The situation is different in the case of classic chemotherapy or the application of biologicals by gastroenterologists in advanced gastrointestinal tumors. This is common practice in certain European countries. Indeed, the use of biologicals is hardly new to gastroenterologists used to treating patients with chronic inflammatory bowel disease.

This book addresses all endoscopists throughout the world as well as colleagues from related fields. It is especially intended for our fellows, for gastroenterologists in private practice and those practicing in tertiary referral centers, who work closely with surgeons, pathologists, radiologists, and oncologists, as well as for all those who are involved in research and participate in clinical studies wherever possible. We are well aware of the great economic differences between the various regions and countries of the world, and we explicitly encourage our colleagues in the developing countries. Our express thanks go to those manufacturers of endoscopes and add-on devices who help to establish gastroenterological and endoscopic training centers for training physicians and assistants in the developing countries.

This edition has seen a change in the group of editors. Jacques Bergman, Alexander Meining, D Nageshwar Reddy, Michael Wallace, and Hisao Tajiri have been brought on board as associate editors in an effort to involve younger endoscopists with solid scientific and clinical reputations, who have already acquired experience and demonstrated sound critical judgment in both research and practice. These colleagues have also played a crucial role in designing the book and will be responsible for the coming editions. We felt it important that they already become familiar with the responsibilities of editors. It is essential for a textbook to keep abreast of the latest developments. New aspects and changing emphasis make it important to enlist younger authors as well. This approach has paid off. However, the majority of our authors had already contributed to the first edition. We know of few gastroenterological book projects with such a broad international group of contributing authors. The editors would like to thank all the authors for their understanding for our urgent wishes and for their outstanding cooperation.

The high quality of text and image material the editors strived for was nearly invariably achieved. We thank the enthusiastic donors (especially from Japan) for their excellent image material.

We present readers throughout the world with a book that does justice to the advances in medical science and to the development and importance of gastroenterological endoscopy. Gastroenterologists throughout the world will receive the information they require for planning an endoscopy department, for their endoscopic work in both private practice and the hospital, and for detecting and treating even rare pathology in the gastrointestinal tract and major digestive glands.

Our special thanks go to the staff of Thieme Publishers, especially Dr. Wachinger and Dr. Bergman. Ms. Rachel Swift not only did justice to her name, but won the editors' boundless admiration for her knowledge, patience, and kindness. Dr. Hauff was a generous publisher who agreed to give the book an excellent layout.

The editors

List of Contributors

Associate Editors

Jacques J. G. J. M. Bergman, MD
Professor
Academic Medical Center
Department of Gastroenterology
Amsterdam, the Netherlands

Alexander Meining, MD
Department of Gastroenterology
Technical University of Munich
Klinikum rechts der Isar
Munich, Germany

D. Nageshwar Reddy, MD
Chairman
Asian Institute of Gastroenterology
Hyderabad, India

Hisao Tajiri, MD
Chairman and Professor
Division of Gastroenterology
and Hepatology
Department of Internal Medicine
The Jikei University School of Medicine
Tokyo, Japan

Michael B. Wallace, MD
Associate Professor of Gastroenterology
Mayo Clinic
Jacksonville, FL, USA

Contributors

Douglas G. Adler MD, FACG, FASGE
Assistant Professor of Medicine
Director of Therapeutic Endoscopy
Gastroenterology and Hepatology
Huntsman Cancer Center
University of Utah
Salt Lake City, UT, USA

Furqaan Ahmed
Fellow, Division of Gastroenterology
and Hepatology
Department of Medicine
Indiana University Medical Center
Indianapolis, IN, USA

Hans-Dieter Allescher, MD
Professor
Klinikum Garmisch-Partenkirchen GmbH
Center for Internal Medicine
Garmisch-Partenkirchen, Germany
Anthony T. R. Axon
Professor of Gastroenterology
Department of Gastroenterology
The General Infirmary at Leeds
Leeds, UK

Rami J. Badreddine, MD
Division of Gastroenterology
and Hepatology
Mayo Clinic
Rochester, MN, USA

John Baillie, MB, ChB, FRCP, FACG
Professor, Internal Medicine
(Gastroenterology)
Director, Hepatobiliary and
Pancreatic Disorders Services
Wake Forest University Baptist
Medical Center
Medical Center Boulevard
Winston-Salem, NC, USA

Juergen Barnert, MD
Supervising Physician
3 rd Medical Department
Klinikum Augsburg
Augsburg, Germany

Todd H. Baron, MD, FASGE
Division of Gastroenterology
and Hepatology
Mayo Clinic
Rochester, MN, USA

Hugh Barr, MD, ChM, FRCS, FRCSE, FHEA
Professor
Cranfield Health
Gloucestershire Royal Hospital
Gloucester, UK

J. F. W. M. Bartelsman
Professor
Department of Gastroenterology
and Hepatology
Academic Medical Center
Amsterdam, the Netherlands

Witold Bartnik, MD
Professor
Department of Gastroenterology
and Hepatology
Medical Center for Postgraduate
Education and
the Maria Sklodowska-Curie
Memorial Cancer Center and Institute
of Oncology
Warsaw, Poland

Vikram Bhatia, MD, DM
Assistant Professor (Medical Hepatology)
Institute of Liver and Biliary Sciences
New Delhi, India

David Bjorkman, MD, MSPH
Dean, University of Utah School of Medicine
Executive Medical Director
Division of Gastroenterology
and Hepatology
Salt Lake City, UT, USA

Wojciech Blonski, MD, PhD
Division of Gastroenterology
University of Pennsylvania
Philadelphia, PA, USA
Department of Gastroenterology
and Hepatology
Medical University
Wroclaw, Poland

Lawrence J. Brandt, MD
Chief, Department of Gastroenterology
Montefiore Medical Center
Albert Einstein College of Medicine
Bronx, NY, USA

Marco J. Bruno, MD, PhD
Erasmus Medical Centre
University Medical Center Rotterdam
Depaertment of Gastroenterology
and Hepatology
Rotterdam, the Netherlands

Andrew K. Burroughs
Consultant Physician and Hepatologist
Liver Transplantation and
Hepatobiliary Medicine
Royal Free Hospital
London, UK

David Cave, MD, PhD
Professor of Medicine
Director of Clinical
Gastroenterology Research
UMass Memorial Medical Center
Worcester, MA, USA

Jean Pierre Charton, MD
Consultant, Gastroenterology
Evangelisches Krankenhaus
Düsseldorf, Germany

Evangelos Cholongitas, MD
Liver Transplantation and
Hepatobiliary Medicine
Royal Free Hospital
London, UK

Meinhard Classen, MD
Professor Emeritus and former Chairman
Department of Internal Medicine
Technical University of Munich
Munich, Gerrmany

Guido Costamagna, MD, FACG
Università Cattolica del Sacro Cuore
A. Gemelli University Hospital
Digestive Endoscopy Unit
Rome, Italy

Stefan von Delius
Assistant Physician
2nd Medical Clinic
Klinikum rechts der Isar
Technical University of Munich
Munich, Germany

Michel Delvaux, MD, PhD
Department of Internal Medicine
and Digestive Pathology
Hopitaux de Brabois
University Hospital of Nancy
Nancy, France

James A. DiSario, MD
Adjunct Professor of Medicine
University of Utah Health Sciences Center
Utah, USA

Steven A. Edmundowicz, MD
FASGE Professor of Medicine
Chief of Endoscopy
Division of Gastroenterology
Washington University School of Medicine
St. Louis, MO, USA

Axel Eickhoff, MD
Medical Department C
Klinikum Ludwigshafen
Academic Hospital of the
University of Mainz
Ludwigshafen, Germany

Shungo Endo, MD
Digestive Disease Center
Showa University Northern
Yokohama Hospital
Yokohama, Japan

Pietro Familiari, MD, PhD
Università Cattolica del Sacro Cuore
A. Gemelli University Hospital
Digestive Endoscopy Unit
Rome, Italy

Paul Feuerstadt, MD
Fellow, Department of Gastroenterology
Montefiore Medical Center
Albert Einstein College of Medicine
Bronx, NY, USA

Hubertus Feußner, MD
Professor
Department of Surgery
Klinikum Rechts der Isar
Technical University of Munich
Munich, Germany

David E. Fleischer, MD
Professor of Medicine
Mayo Clinic College of Medicine
Division of Gastroenterology
and Hepatology
Scottsdale, AZ, USA

Evan L. Fogel
Professor of Clinical Medicine
Indiana University School of Medicine
Division of Gastroenterology
and Hepatology
Department of Medicine, Indiana University
Medical Center
Indianapolis, IN, USA

Victor L. Fox, MD, FAAP
Director, Gastroenterology Procedure Unit
Assistant Professor of Pediatrics
Harvard Medical School
Children's Hospital Boston
Boston, MA, USA

Gérard Gay, MD
Department of Internal Medicine
and Digestive Pathology
Hopitaux de Brabois
University Hospital of Nancy
Nancy, France

Karel Geboes, MD
Professor
Department of Pathology
University Hospital KULeuven
Leuven, Belgium

Joseph E. Geenen, MD
Clinical Professor of Medicine
Medical College of Wisconsin
Director, Pancreatobiliary Services
St.Luke's Medical Center
Milwaukee, WI, USA

Nalini M. Guda, MD
Clinical Associate Professor of Medicine
University of Wisconsin School of Medicine
and Public Health
Pancreatobiliary Services
St.Luke's Medical Center
Milwaukee, WI, USA

Neil Gupta, MD, MPH
Fellow, Division of
Gastroenterology/Hepatology
University of Kansas Medical Center
Kansas City Veterans Administration
Kansas City, MO, USA

Gregory B. Haber, MD
Director of Gastroenterology
Lenox Hill Hospital
New York, NY, USA

Robert H. Hawes, MD
Professor of Medicine
Peter Cotton Chair for
Endoscopic Innovation
Division of Gastroenterology
and Hepatology
Digestive Disease Center
Medical University of South Carolina
Charleston, SC, USA

Juergen Hochberger, MD, PhD
Professor of Medicine and Chairman
Department of Medicine III –
Gastroenterology, Interventional Endoscopy
St. Bernward Academic Teaching Hospital
Hildesheim, Germany

Keiichi Ikeda, MD
Department of Endoscopy
The Jikei University School of Medicine
Tokyo, Japan

John M. Inadomi, MD
GI Health Outcomes
Policy and Economics (HOPE)
Research Program
Department of Medicine
University of California
San Francisco, USA

Sreeni Jonnalagadda, MD
Associate Professor of Medicine
Director of Biliary and Pancreatic Endoscopy
Interventional Endoscopy Section
Washington University School of Medicine
St. Louis, MO, USA

Michael Jung, MD, FRCP
Professor and Chief Physician
Department of Gastroenterology
St. Hildegardis-Krankenhaus
Katholisches Klinikum Mainz
Mainz, Germany

Abdel Meguid Kassem, MD
Associate Professor
Department of Tropical Medicine
and GI-Endoscopy
Faculty of Medicine, Cairo University
Cairo, Egypt

Ralf Kiesslich
Professor and Chief
Endoscopy Unit
1st Medical Department
Johannes Gutenberg University
Mainz, Germany

Kiyonori Kobayashi, MD
Department of Gastroenterology
Kitasato University East Hospital
Sagamihara, Japan

David Kotlyar, MD
University of Pennsylvania
School of Medicine
Philadelphia
Pennsylvania, USA

Richard A. Kozarek, MD
FASGE Division of Gastroenterology
Virginia Mason Medical Center
Seattle, WA, USA

Shin-ei Kudo, MD
Digestive Disease Center
Showa University Northern
Yokohama Hospital
Yokohama, Japan

Spiros D. Ladas, MD
Professor of Medicine and Gastroenterology
Chairman, 1st Department of
Internal Medicine
Laiko General Hospital of Athens
Medical School, University of Athens
Athens, Greece

James Y. W. Lau, MD
Department of Surgery
Prince of Wales Hospital
Shatin
Hong Kong, China

Glen A. Lehman, M. D.
Indiana University Medical Center
Department of Medicine
Division of Gastroenterology
and Hepatology
Indianapolis, IN, USA

Blair S. Lewis, MD
The Mount Sinai School of Medicine
New York, NY, USA

Gary R. Lichtenstein, MD
Professor of Medicine
University of Pennsylvania
School of Medicine
Director, Center for
Inflammatory Bowel Disease
University of Pennsylvania Health System
Division of Gastroenterology
Philadelphia, PA, USA

Jenifer R. Lightdale, MD, MPH
Attending Physician
Gastroenterology and Nutrition
Children's Hospital Boston
Boston, MA, USA

Juergen Maiss, MD, PhD
Kerzel & Maiss
Gastroenterology Associates
Forchheim, Germany

Elisabeth M. H. Mathus-Vliegen, MD
Professor
Department of Gastroenterology
and Hepatology
Academic Medical Centre
Amsterdam, the Netherlands

Koji Matsuda, MD, PhD
Department of Endoscopy
The Jikei Unversity Aoto Hospital
Tokyo, Japan

Kai Matthes, MD, PhD
Division of Gastroenterology
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, MA, USA

Helmut Messmann, MD
Professor and Director
3 rd Medical Department
Klinikum Augsburg
Augsburg, Germany

Hideyuki Miyachi, MD
Digestive Disease Center
Showa University Northern
Yokohama Hospital
Yokohama, Japan

Faris M. Murad, MD
Advanced Fellow
Gastroenterology,
Advanced Therapeutic Endoscopy
Mayo Clinic
Rochester, MN, USA

Horst Neuhaus, MD
Professor and Chief Physician
Department of Gastroenterology
Evangelisches Krankenhaus
Düsseldorf, Germany

H. Juergen Nord,
MD, MACG, FACP, FASGE, AGAF
Professor of Medicine
University of South Florida
College of Medicine
Tampa, FL, USA

Hiroyuki Ono, MD
Chief of Endoscopy
Shizuoka Cancer Center
Shizuoka, Japan

Jacek Pachlewski, MD
Department of Gastroenterology
and Hepatology
Medical Center for Postgraduate Education
Maria Sklodowska-Curie Memorial
Cancer Center and Institute of Oncology
Warsaw, Poland

Sandy H. Y. Pang, MD
Department of Medicine and Therapeutics
Prince of Wales Hospital
Shatin
Hong Kong, China

Shabana F. Pasha, MD
Assistant Professor of Medicine
Division of Gastroenterology
and Hepatology
Mayo Clinic College of Medicine
Scottsdale, AZ, USA

Andrew T. Pellecchia, MD
Attending Physician
Department of Gastroenterology
Jacobi Medical Center /
Albert Einstein College of Medicine
Bronx, NY, USA

Jan-Werner Poley, MD
Erasmus Medical Centre
University Medical Center Rotterdam
Department of Gastroenterology
and Hepatology
Rotterdam, the Netherlands

Thierry Ponchon, MD
Professor
Department of Gastroenterology
and Hepatology
Hôpital Eduard Herriot
Lyon, France

Jeffrey L. Ponsky
Oliver H. Payne Professor and Chairman
Department of Surgery
Case Western Reserve University
School of Medicine
Case Medical Center
Cleveland, OH, USA

Benjamin K. Poulose, MD, MPH
Assistant Professor of Surgery
Vanderbilt University Medical Center
Nashville, TN, USA

Christian Prinz, MD
2nd Medical Department
Klinikum Rechts der Isar
Technical University of Munich
Munich, Germany

D. Nageshwar Reddy, MD
Chairman
Asian Institute of Gastroenterology
Hyderabad, India

Jaroslaw Regula, MD
Professor
Department of Gastroenterology
and Hepatology
Medical Center for Postgraduate Education
Maria Sklodowska-Curie Memorial
Cancer Center and Institute of Oncology
Warsaw, Poland

Jürgen F. Riemann, MD
Chairman and Professor
Medical Department C
Klinikum Ludwigshafen
Ludwigshafen, Germany

Thomas Rösch, MD
Chief of Endoscopy
Klinik rechts der Isar
Technical University of Munich
Munich, Germany

Gurpal S. Sandha
Assistant Professor
Division of Gastroenterology
University of Alberta
Edmonton, AB, Canada

Yasushi Sano, MD, PhD
Director and Chief
Gastrointestinal Center
Sano Hospital
Kobe, Japan

Shiv Kumar Sarin, MD, DM
Professor
Institute of Liver and Biliary Sciences
New Delhi, India

Brian Saunders, MD, FRCP
Consultant Gastroenterologist
and Specialist GI Endoscopist
Director, Wolfson Unit for Endoscopy
St. Mark's Hospital
Harrow, United Kingdom

Stefan Seewald, MD
Center of Gastroenterology
Klinik Hirslanden
Zurich, Switzerland

Marco Senzolo, MD
Liver Transplantation and
Hepatobiliary Medicine
Royal Free Hospital
London, United Kingdom

Prateek Sharma, MD
Professor
Division of Gastroenterology/Hepatology
University of Kansas Medical Center
Kansas City Veterans Administration
Kansas City, MO, USA

Stuart Sherman, MD
Professor of Medicine
Glen Lehman Professor in Gastroenterology
Division of Gastroenterology
and Hepatology
Department of Medicine
Indiana University Medical Center
Indianapolis, IN, USA.

Chan-Sup Shim, MD, PhD
Director of Digestive Disease Center
KonKuk University Medical Center
Seoul, Korea

Nathan J. Shores, MD
Fellow
Section on Gastroenterology
Department of Internal Medicine
Wake Forest University Health System
Winston-Salem, NC, USA

Nib Soehendra, MD
Professor Emeritus
Senior Advisor
Universitätsklinikum Hamburg-Eppendorf
Hamburg, Germany

Ma Somsouk, MD, MAS
GI Health Outcomes, Policy
and Economics (HOPE) Research Program
Department of Medicine
University of California, San Francisco
Division of Gastroenterology
and Hepatology
San Francisco General Hospital
San Francisco, CA, USA

Joseph J. Y. Sung, MBBS, MD, PhD, FRCP
Chairman and Professor of Medicine
Department of Medicine and Therapeutics
Director, Institute of Digestive Disease
The Chinese University of Hong Kong
Hong Kong, China

Paul Swain, MD
Professor of Gastrointestinal Endoscopy
Department of Surgical Oncology
and Technology
Imperial College of Science,
Technology and Medicine
London, United Kingdom

Hisao Tajiri, MD, PhD
Chairman and Professor
Division of Gastroenterology
and Hepatology
Professor
Department of Endoscopy
The Jikei University School of Medicine
Tokyo, Japan

Shinji Tanaka, MD, PhD
Professor and Director
Department of Endoscopy
Hiroshima University Hospital
Hiroshima, Japan

George Triadafilopoulos, MD
Department of Medicine
Division of Gastroenterology
and Hepatology
Stanford University
Stanford, CA, USA

Andrea Tringali, MD, PhD
Università Cattolica del Sacro Cuore
A. Gemelli University Hospital
Digestive Endoscopy Unit
Rome, Italy

K. M. A. J. Tytgat, MD, PhD
Department of Gastroenterology
Academic Medical Center
Amsterdam, the Netherlands

Guido N. J. Tytgat, MD, PhD
Professor Emeritus of Gastroenterology
University of Amsterdam
Former Chief of Department
of Gastroenterology
Academic Medical Center
Amsterdam, the Netherlands

Kenneth K. Wang, MD, PhD
Director
Advanced Endoscopy Group
Division of Gastroenterology
and Hepatology
Mayo Clinic
Rochester, MN, USA

Jerome D. Waye, MD
Department of Gastroenterology
Mount Sinai Medical Center
New York, NY, USA

Justin C.Y. Wu, MBChB, MD, FRCP
Associate Professor
Department of Medicine and Therapeutics
The Chinese University of Hong Kong
Hong Kong, China

Byung Moo Yoo, MD
Indiana University Medical Center
Department of Medicine
Division of Gastroenterology
and Hepatology
Indianapolis, IN, USA

Contents

I Development of Endoscopy

Section editors: Meinhard Classen, Guido N.J. Tytgat, Charles J. Lightdale

II The Patient and Endoscopy

Section editors: Guido N.J. Tytgat, Meinhard Classen, Charles J. Lightdale

III Teaching and Learning

Section editors: Meinhard Classen, Guido N.J. Tytgat, Charles J. Lightdale

IV Diagnostic Procedures and Techniques

Section editors: Meinhard Classen, Guido N.J. Tytgat, Michael B. Wallace

V Therapeutic Procedures

Section editors: Guido N.J. Tytgat, Meinhard Classen and Charles J. Lightdale

VI Upper Gastrointestinal Tract Disease

Section editors: Charles J. Lightdale, H. Tajiri, J. Bergman

VII Lower Gastrointestinal Tract Diseases

Section editors: Charles J. Lightdale, Guido N.J. Tytgat, Alexander Meining

VIII Biliopancreatic, Hepatic, and Peritoneal Diseases

Section editors: Charles J. Lightdale, Meinhard Classen, D. Nageshwar Reddy

IX Infectious Diseases of the Gastrointestinal Tract

Section editors: Guido N.J. Tytgat, Charles J. Lightdale, MIchael B. Wallace

X Pediatric Endoscopy

Section editors: Charles J. Lightdale, Meinhard Classen, Guido N.J. Tytgat

Abbreviations

airway breathing and circulation	ABC
blood transfusion requirement index	ABRI
American Cystoscope Makers Inc.	ACMI
acute colonic pseudo-obstruction	ACPO
autofluorescence imaging	AFI
American Gastroenterological Association	AGA
acute gallstone pancreatitis	AGP
American Heart Association	AHA
acquired immune deficiency syndrome	AIDS
autoimmune pancreatitis	AIP
aminolevulinic acid	ALA
alanine aminotransferase .	ALT
American Medical Association	AMA
analysis of variance	ANOVA
Asia–Pacific Association for the Study of the Liver	APASL
adenomatous polyposis coli gene	APC
Argon plasma coagulation	APC
antireflux device	ARD
American Society of Anesthesiologists	ASA
adjustable silicone gastric banding	ASGB
American Society of Gastrointestinal Endoscopy	ASGE
aspartate aminotransferase	AST
arteriovenous malformation	AVM
BioEnterics Intragastric Balloon	BIB
bipolar electrocoagulation	BICAP
body mass index	BMI
biliopancreatic diversion	BPD
biliopancreatic diversion with duodenal switch	BPD-DS
balloon-occluded retrograde transvenous obliteration	BRTO
bovine spongiform encephalopathy	BSE
British Society of Gastroenterology	BSG
chronic antral gastritis	CAG
computer-assisted personalized sedation	CAPS
computer-based colonoscopy simulator	CBCS
common bile duct	CBD
charge-coupled device	CCD
colitis cystica profunda	CCP
Crohn disease	CD
Crohn Disease Activity Index	CDAI
Crohn Disease Endoscopic Index of Severity	CDEIS
carcinoembryonic antigen	CEA
capsule endoscopy Crohn disease activity index	CECDAI
cylindrical insertion	CI
cytokeratins	CKs
columnar-lined lower esophagus	CLE
confocal laser endomicroscopy	CLE
Cytomegalovirus	CMV
carbon dioxide	CO_2
Cyclooxygenase-2	COX-2
celiac plexus neurolysis	CPN
complete portal tracts	CPTs
colorectal cancer	CRC
controlled radial expansion	CRE
calcinosis Raynaud phenomenon sclerodactyly and telangiectasia	CRST
cylindrical surface	CS
clinically significant portal hypertension	CSPH
centimeter	cm
computed tomography	CT
computed-tomographic angiography .	CTA
diffuse antral gastritis	DAG
dysplasia-associated lymphoid mass	DALM
double-balloon endoscopy	DBE
dilated intercellular spaces	DIS
diisopropyl iminodiacetic acid	DISIDA
dimethyl sulfoxide	DMSO
desoxyribonucleic acid	DNA
direct percutaneous endoscopic jejunostomy	DPEJ
deep venous thrombosis	DVT
Erlangen Active Simulator for Interventional Endoscopy	EASIE
endoscopic band ligation	EBL
electrocardiography	ECG
enterochromaffin-like	ECL
early gastric cancer	EGC
esophagogastroduodenoscopy	EGD
epidermal growth factor receptor	EGFR
esophagogastric junction	EGJ
enterohemorrhagic *E. coli*	EHEC
electrohydrolic lithotripsy	EHL
electrohydraulic lithotripsy	EHL
electrohydrothermal [probes]	EHT
enteroinvasive *E. coli*	EIEC
endoscopic injection sclerotherapy	EIS
enzyme-linked immunosorbent assay	ELISA
endoscopic laser therapy	ELT
endoscopic mucosal resection	EMR
cap-assisted endoscopic mucosal resection	EMR-C
ligation-assisted EMR	EMR-L
endoscopic polypectomy	EP
European Panel on Appropriateness of Gastrointestinal Endoscopy	EPAGE
endoscopic papillary balloon dilation	EPBD
endoscopic papillotomy	EPT
endoscopic retrograde cholangiography	ERC
endoscopic retrograde cholangiopancreatography	ERCP
endoscopic resection using a hypertonic saline–epinephrine	ERHSE
endoscopic submucosal dissection	ESD
European Society of Gastrointestinal Endoscopy	ESGE
European Society of Gastroenterology and Endoscopy Nurses and Associates	ESGENA
endoscopic sphincterotomy	EST
extracorporeal shock-wave lithotripsy	ESWL
endoscopic transanal resection	ETAR
enteropathy-type T-cell lymphoma	ETL
endoscopic trimodality imaging	ETMI
European Board of Anesthesiology of the European Union of Medical Specialists	EUMS/UEMS
endoscopic ultrasonography	EUS
gastrointestinal endosonography	EUS

endoscopic variceal ligation	EVL
ethylene-vinyl alcohol	EVOH
familial adenomatous polyposis	FAP
Food and Drug Administration	FDA
fresh frozen plasma	FFP
free hepatic venous pressure	FHVP
Fujinon intelligent chromoendoscopy	FICE
fluorescent in-situ hybridization	FISH
fine-needle aspiration	FNA
fine-needle aspiration biopsy	FNAB
fine-needle injection	FNI
fine-needle puncture	FNP
French size	Fr
front surface .	FS
gauge	G
gastric antral vascular ectasia	GAVE
gastric bypass	GBP
gastroesophageal flap valve	GEFV
Garren–Edwards Gastric Bubble	GEGB
gastroesophageal junction	GEJ
gastroesophageal reflux disease	GERD
GERD health-related quality of life	GERD-HRQL
Groupe d'Etudes Thérapeutiques des Affections Inflammatoires du Tube Digestif	GETAID
gastroesophageal varices	GEV
gastroesophageal varices	GEVs
gamma glutamyltransferase	gGT
gastrointestinal	GI
gastrointestinal stromal tumor	GIST
Global Rating Scale .	GRS
glyceryl trinitrate	GTN
graft-versus-host disease	GVHD
gastric variceal obturation	GVO
highly active antiretroviral therapy	HAART
hepatitis B virus	HBV
hepatocellular carcinoma	HCC
hepatitis C virus	HCV
hernia diaphragmatica	HD
high-grade dysplasia	HGD
high-grade intraepithelial neoplasia	HGIN
hereditary hemorrhagic telangiectasia	HHT
hepatoiminodiacetic acid	HIDA
human immunodeficiency virus	HIV
hereditary nonpolyposis colorectal cancer	HNPCC
hereditary nonpolyposis colorectal cancer	HNPCC
holmium:yttrium–aluminum–garnet	Ho:YAG
human papillomavirus	HPV
herpes simplex virus	HSV
hemolytic uremic syndrome	HUS
hepatic venous pressure gradient	HVPG
hepatic venous pressure gradient	HVPG
The Hygiene in Gastroenterology—Endoscope Reprocessing study [*Hygiene in der Gastroenterologie – Endoskop-Aufbereitung*]	HYGEA
herz	Hz
internal anal sphincter	IAS
inflammatory bowel disease	IBD
International Conference on Capsule Endoscopy	ICCE
intravenous indocyanine green	ICG
intraductal ultrasonography	IDUS
idiopathic esophageal ulceration	IEU
immunoglobulin G	IgG
immunoglobulin G4	IgG4
immunoglobulin M	IgM
isolated gastric varices	IGVs
international normalized ratio	INR
ileal pouch–anal anastomosis	IPAA
immunoproliferative small-intestinal disease	IPSID
isosorbide dinitrate	ISDN
insulated-tip	IT
IT knife-2	IT-2
internal vena cava	IVC
Joule	J
jejunoileal bypass	JIB
jejunostomy through a PEG	JPEG
juvenile polyposis syndrome	JPS
potassium titanyl phosphate	KTP
liter	l
laparoscopic adjustable silicone gastric banding	LASGB
laparoscopic cholecystotomy	LCT
laparoscopic–endoscopic procedure	LEP
lower esophageal sphincter	LES
liver function tests	LFTs
low-grade dysplasia	LGD
lower gastrointestinal bleeding	LGIB
low-grade intraepithelial neoplasia	LGIN
lymphogranuloma venereum	LGV
laser lithotripsy	LL
low-molecular-weight heparin	LMWH
low-osmolality nonionic contrast media	LOCM
laterally spreading tumor	LST
Mycobacterium avium complex	MAC
mucosa-associated lymphoid tissue	MALT
minilaparoscopy-assisted natural orifice surgery	MANOS
MUTYH gene–associated polyposis	MAP
magnetic endoscope imaging	MEI
multiple endocrine neoplasia	MEN
myocardial infarction	MI
milliliter	ml
mechanical lithotripsy	ML
millimeter	mm
mitochondrial neurogastrointestinal encephalomyopathy	MNGIE
main pancreatic duct	MPD
magnetic resonance cholangiography	MRC
magnetic resonance cholangiopancreatography	MRCP
magnetic resonance imaging	MRI
microsatellite instability	MS
microsatellite instability	MSI
Men who have sex with men	MSM
methyl *tert*-butyl ether	MTBE
temoporfin	mTHPC
metaplasia ulceration stricture and esophagitis	MUSE
nucleic acid amplification tests	NAATs
nurse-administered propofol sedation	NAPS
narrow-band imaging	NBI
neodymium:yttrium–aluminum–garnet	Nd:YAG
North Italian Endoscopic Club	NIEC
National Institutes of Health	NIH
nanometer	nm
number needed to treat	NNT
Natural Orifice Surgery Consortium for Assessment and Research	NOSCAR
natural orifice transluminal endoscopic surgery	NOTES
nonsteroidal anti-inflammatory drugs	NSAIDs
nonselective beta-blockers	NSBBs
New York Society for Gastrointestinal Endoscopy	NSYGE
One-Action Stent Introduction System	OASIS
optical coherence tomography	OCT
World Organization of Digestive Endoscopy [Organisation Mondiale d'Endoscopie Digestive]	OMED
ortho-phthalaldehyde	OPA

over-the-wire	OTW
picture archiving and communication system	PACS
analogue broadcasting systems	PAL and NTSC
periodic acid–Schiff	PAS
patient-controlled analgesia–sedation	PCAS
polymerase chain reaction	PCR
photodynamic therapy	PDT
percutaneous endoscopic cecostomy	PEC
percutaneous endoscopic colostomy	PEC
percutaneous endoscopic gastrostomy	PEG
polyethylene glycol–electrolyte solution	PEG-ELS
percutaneous endoscopic jejunostomy	PEJ
positron-emission tomography	PET
porfimer sodium	Photofrin
percutaneous liver biopsy	PLB
pseudomembranous colitis	PMC
peroral cholangioscopy	POC
pulsatile organ perfusion	POP
proton-pump inhibitors	PPI
protoporphyrin IX	PpIX
positive predictive value	PPV
packed red blood cells.	PRBC
primary sclerosing cholangitis	PSC
percutaneous transhepatic biliary drainage	PTBD
percutaneous transhepatic cholangiography	PTC
percutaneous transhepatic cholangiographic drainage	PTCD
percutaneous transhepatic cholangioscopy	PTCS
polytetrafluoroethylene	PTFE
percutaneous transhepatic papillary balloon dilation	PTPBD
percutaneous ultrasound guidance	PUG
Quality Assurance of Hygiene in Endoscopy [Qualitätssicherung der Hygiene in der Endoskopie]	QSHE
randomized controlled trial	RCT
radiofrequency	RF
Robotics Interactive Endoscopy Simulation	RIES
relative risk	RR
Roux-en-Y gastric bypass	RYGB
Society of American Gastrointestinal Endoscopic Surgeons	SAGES
small bowel endoscopy	SBE
squamous cell carcinoma	SCC
specialized columnar epithelium	SCE
squamocolumnar junction	SCJ
submucosal endoscopy with mucosal flap	SEMF
self-expanding metal stent	SEMS
self-expanding plastic stent	SEPS
Simple Endoscopic Score for Crohn Disease	SES-CD
sphincter of Oddi dysfunction	SOD
stigmata of recent hemorrhage	SRH
solitary rectal ulcer syndrome	SRUS
secretin stimulation MRCP	ss-MRCP
sodium tetradecyl sulfate	STD
stone–tissue discrimination system	STDS
sexually transmitted proctitis	STP
Tissue Apposition System	TAS
target-controlled infusion	TCI
transendoscopic microsurgery	TEMS
transforming growth factor-β	TGF-β
transoral incisionless fundoplication	TIF
transjugular intrahepatic portosystemic shunt	TIPS
transjugular liver biopsy	TJLB
transient LES relaxations	tLESRs
tumor necrosis factor-α	TNF-α
tumor node metastasis	TNM
transoral gastroplasty	TOGA
total pancreatectomy with islet cell autotransplantation	TP-IAT
through-the-scope	TTS
ulcerative colitis	UC
ursodeoxycholic acid	UDCA
ultrasonography	US
vertical banded gastroplasty	VBG
video capsule endoscopy	VCE
variant Creutzfeldt–Jakob disease	vCJD
vascular endothelial growth factor	VGEF
Watt	W
automated washer-disinfectors	WDs
wedged hepatic venous pressure	WHVP
walled-off pancreatic necroses	WOPNs

I Development of Endoscopy

Section editors:
Meinhard Classen, Guido N.J. Tytgat, Charles J. Lightdale

1 Two Centuries of Digestive Tract Endoscopy: a Concise Report

Meinhard Classen

Introduction

This report on the fascinating recent history of digestive tract endoscopy, its pioneers, and the sometimes revolutionary discoveries and developments that have been seen in the field makes no claim either to completeness or to absolute accuracy. In his excellent book on the history of endoscopy, Francisco Vilardell draws attention to the uncertainties involved in identifying the real originator of any method—whenever this author fails, it should always be regarded as a matter of *nescientia* rather than *ignorantia*. Important and first-rate histories of the field have been written by Irvin M. Modlin (*A Brief History of Endoscopy*) and Francisco Vilardell (*Digestive Endoscopy in the Second Millennium*)—books that can be strongly recommended to every endoscopist [1,2].

Nineteenth-Century Pioneers

Philipp Bozzini (1773–1809), a physician responsible for public health in Frankfurt am Main in Germany, is recognized as the founding father of endoscopy. The light-conducting system which he developed in 1806 and used to inspect the orifices featured a candle and a system of prisms (**Fig. 1.1**) [3]. A better light source was provided in 1853 by the alcohol–turpentine lamp used for cystoscopy by Antonin Desormeaux (1815–1894). The same light source was used in 1868 by Adolph Kussmaul (1822–1902, **Fig. 1.2**) [4], for the first examination of the esophagus, in a sword-swallower—with a rigid endoscope, of course.

The year 1879 is celebrated as heralding the birth of modern endoscopy, when Max Nitze (1848–1906) presented his *Blasenspiegel,* a cystoscope. The device included a distal platinum lamp and a magnifying optical system and was also capable of being used in the rectum. The surgeon Johannes von Mikulicz-Radecki (1850–1905, **Fig. 1.3**), is regarded as the pioneer of gastroscopy [5]. He was able to identify the pylorus and visualize carcinomas in the stomach.

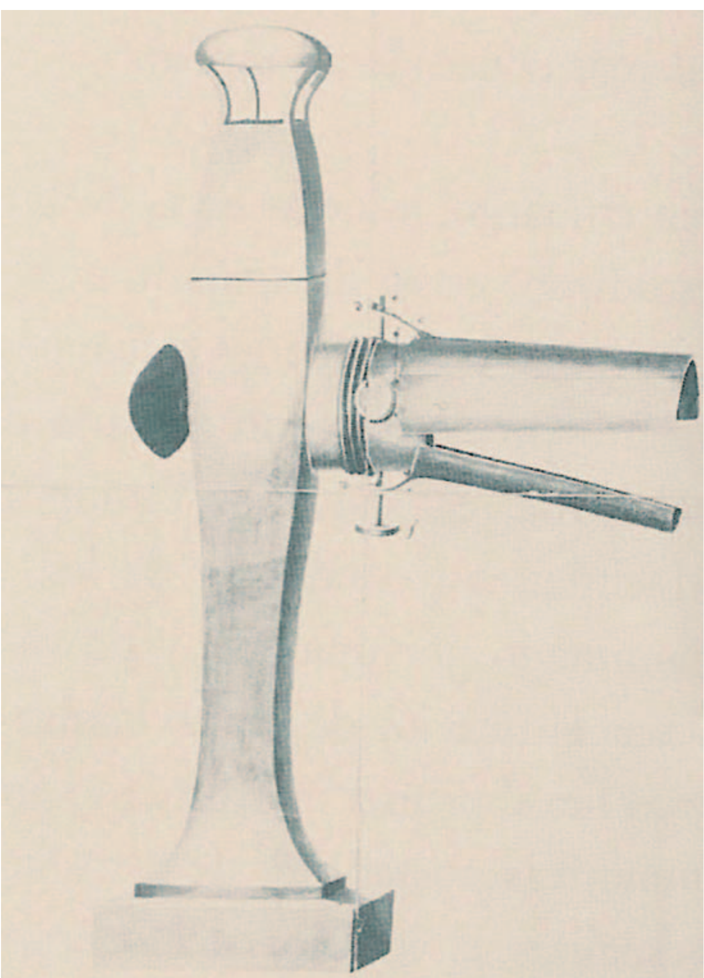


Fig. 1.2 Adolf Kussmaul (1822–1902).

◁ **Fig. 1.1** The original sketch of the light conductor, drawn by Philipp Bozzini himself.

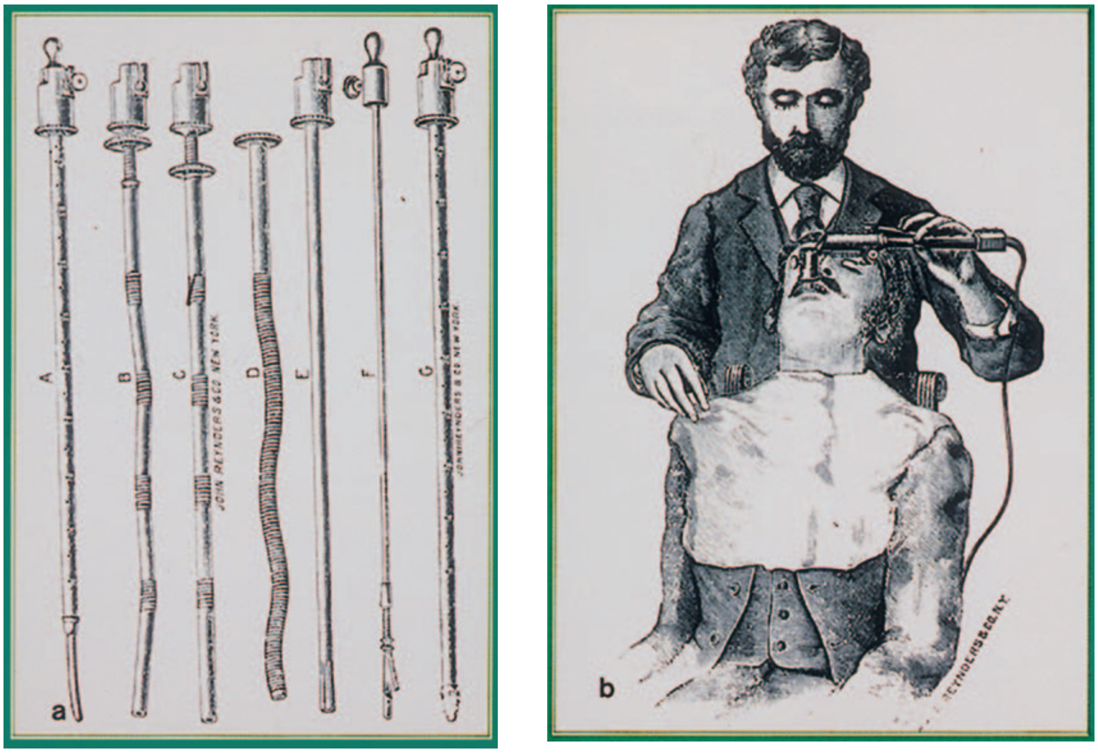
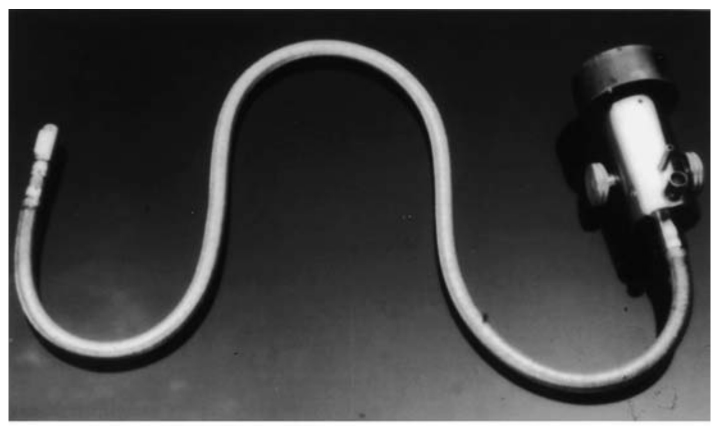


Fig. 1.3 Johannes von Mikulicz’s esophagoscope, 1881.

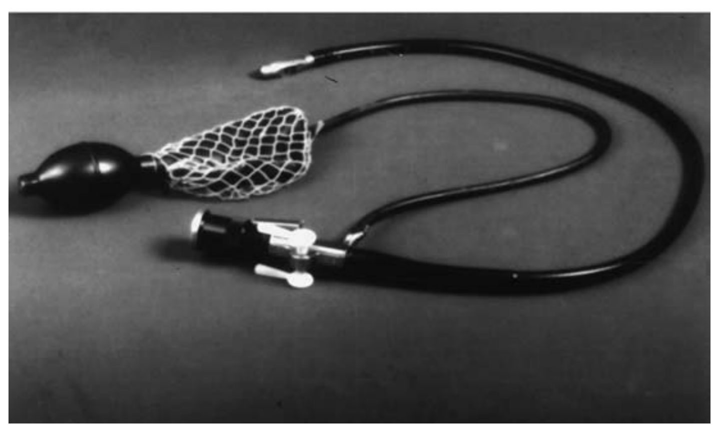
The light bulb invented by Thomas Edison in 1870 was quickly incorporated into endoscopes. The next generation of endoscopes, from the workshop of instrument-maker Josef Leiter (1830–1892) in Vienna, was used for many generations for esophagoscopy, bronchoscopy, and thoracoscopy. With the technology available at the time, numerous further attempts to reduce the rigidity of the instruments, improve illumination conditions, and overcome the limited visualization in the organs being inspected remained unsuccessful.

Rudolf Schindler and the “Semiflexible” Endoscope

In 1932, Rudolf Schindler (1888–1968, **Fig. 1.6**), together with the instrument-maker Georg Wolf (1873–1938), developed a gastroscope in which the proximal end was still rigid but the distal end was capable of being angled up to 34 °, so that it was slightly easier to introduce it into the stomach (**Fig. 1.5**) [6]. When using a successor model to this device, I personally found that passage of the instrument was not very easy—particularly in older patients with a short neck, limited cervical spine mobility, large teeth, and a small mouth. In addition, it was not possible to visualize the esophagus and duodenum at all, and only limited inspection of the stomach was possible. Later developments, such as the modification described by Norbert Henning (1896–1985), included a biopsy channel and a facility for photographic documentation [7]. The watercolor illustrations that had been used to record pathological findings before this are evidence of the artistic skills of Schindler and of Henning, as well as those of an endoscopy nurse working with the French gastroscopist François Moutier (1881–1961, **Fig. 1.7**). Schindler suffered the tragic fate of many refugees from Nazi Germany, after being imprisoned in the concentration camp in Dachau for 6 months in 1934. He left Germany and made a new home in the United States. Even today he is still honored as a missionary in the cause of endoscopy, and as the founder of the American Society for Gastrointestinal Endoscopy—thanks in particular to his charismatic qualities as a teacher. He died in Munich in 1968.



a



b

Fig. 1.4 Two gastroscopes.
a The prototype for the fiber gastroscope (1957).
b The first commercial Hirschowitz fiber gastroscope (1961).

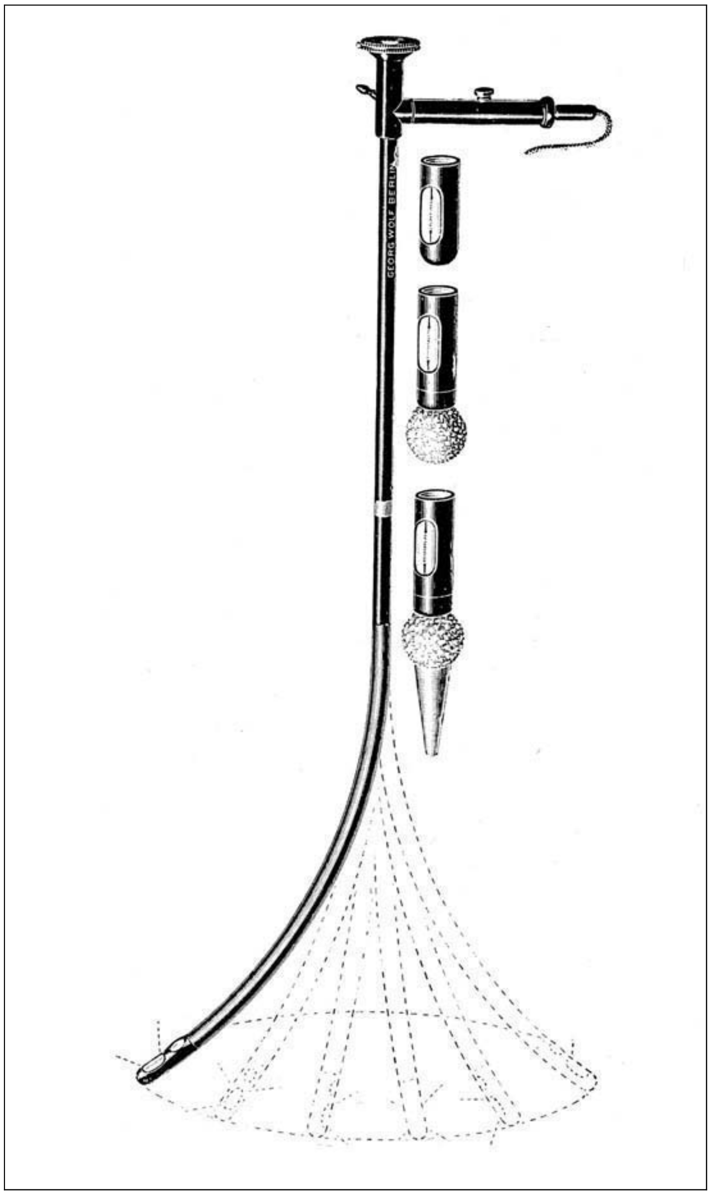


Fig. 1.5 The semiflexible Wolf–Schindler gastroscope (1932).

Fig. 1.6 Rudolf Schindler performing a gastroscopy, with his wife Gabriele holding the patient's head.

Fiberglass Endoscopy and Electronic Endoscopy

The watershed in endoscopy was the development of the fully flexible fiber endoscope by Basil Hirschowitz and colleagues [8]. Heinrich Lamm, a student in Munich, had already developed a model for transmitting light through glass fibers as early as 1927, which he showed to Rudolf Schindler [9]. In 1954, Hopkins and Kapany reported in the journal *Nature* on light transmission through a bundle of parallel glass fibers [10]. The decisive advances that followed involved the use of high-quality clear fiberglass and the isolation of each fiber to prevent light from crossing into neighboring fibers. The problems involved were overcome by Basil Hirschowitz's associates, and by Lawrence E. Curtiss in particular [11,12], and in 1957 the first laboratory prototype of a fiber gastroscope was able to produce a recognizable image of President Lincoln on an American stamp (**Fig. 1.4a**; **Fig. 1.8**).

Several years then passed before American Cystoscope Makers, Inc. (ACMI) developed an industrial product based on the prototype. A few years later, an instrument channel and Bowden cables for controlling the tip of the instrument were incorporated into it. In 1963, an esophagoscope with a second fiberglass bundle for transmitting light (cold light) was developed, followed by a "panendoscope" with prograde viewing that also made it possible to inspect the duodenum. It should also be mentioned that Rudolf Ottenjann, Rita Hohner, and H. Petzel in 1966 attached Bowden cables to the fiber gastroscope available at the time, which was flexible but had not hitherto been controllable, to allow regular visualization of the cardia by inverting the tip of the instrument [13].

Fiberglass endoscopes were quickly developed for inspection of the colon as well. Initial attempts to advance a fiberglass endoscope as far as the cecum were made by Provenzale and Revignas [14]. They used a plastic thread for the purpose; following peroral passage of the thread through the stomach and bowel, the colonoscope was pulled up on it into the right colon. In 1963, Overholt in the USA had already inspected the rectum and sigmoid using a fiberglass endoscope [15].

In electronic or video endoscopy, the coherent fiberglass bundle for image transmission is replaced with a tiny chip camera at the tip of the instrument. The American company Welch Allyn manufactured the first usable device of this type in 1983 [16–18]. The new types of device made by Japanese manufacturers took the world of endoscopy by storm. These instruments made the endoscopist's work easier by providing binocular vision and allowed many types of image processing and image alteration. The final domains reserved for fiberglass endoscopy—the narrow lumina in the bronchi and intrahepatic bile ducts, as well as in the pancreatic ductal system—have now also been conquered by chip endoscopes with a diameter of 1 mm.

Japanese Contributions to Digestive Tract Endoscopy

An early gastrocamera that had been developed by F. Lange and N. Meltzing in 1893 was unsuccessful, as it only provided monochrome images [19] (**Fig. 1.9**). By contrast, the gastrocamera produced by Tatsuro Uji together with the Olympus Optical Co. in Tokyo in 1952 provided the technology that allowed mass screening examinations to be carried out for early recognition of gastric cancer in Japan [20]. Keiichi Kawai and colleagues developed an endoscopic classification of early gastric carcinomas and were also able to show that these lesions develop further to become advanced carcinomas. Mass screening appears to have significantly reduced the mortality due to gastric cancer in Japan. Pioneering advocates of the gastrocamera

Fig. 1.7 Watercolors of pathological gastric findings made by endoscopy nurse Claire Escoube with François Moutier after a glimpse through the gastroscope (1925).

Fig. 1.8 The first photo taken through the new prototype instrument in 1975—a stamp showing President Lincoln.

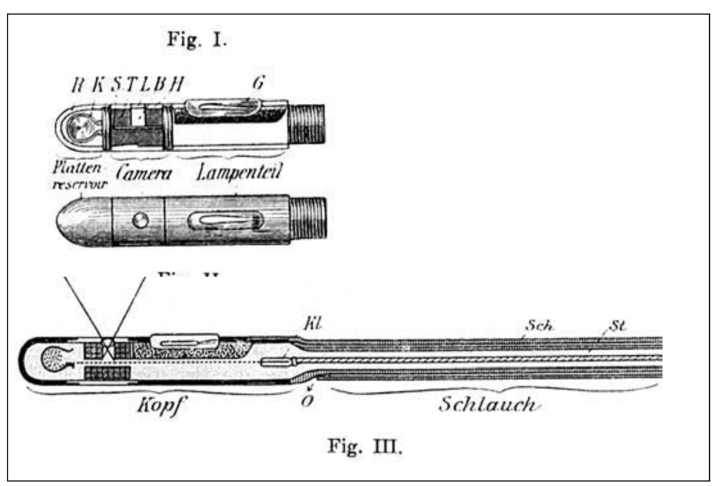


Fig. 1.9 Design drawing for the Meltzing and Langer gastrocamera (1898).

in Germany included K. Heinkel, A. Oshima, and U. von Gaisberg, but in contrast to endoscopy a breakthrough with this type of device was not achieved in Germany [21].

The history of endoscopy in Japan began with the purchase of a Hirschowitz gastroscope by Professor Kondo of Tokyo Women's Medical College in 1960. Kondo had to purchase the device personally, as no academic or other institutions were willing to accept the cost. But things then started to move very quickly. The powerful optical industry in Japan was able to offer a fiberglass gastroscope as early as 1963, and in 1966 the device became available with an angling mechanism and a biopsy channel (the GF-B model by Olympus Optical Co., **Fig. 1.10**). The achievements of Japanese gastroenterologists and instrument manufacturers are evident throughout the present volume.

Colonoscopy

Initial efforts to construct a colonoscope were made as early as 1964 by Hirohumi Niwa, together with the Olympus Optical Co. [22]. Niwa's device was intended for the left colon, but Matsunaga was already planning an endoscope that would allow examination of the whole colon—although it was only able to reach the right colon in 8 % of cases. Via numerous stages of development, a colonoscope approaching today's standard was ultimately developed, with an angle of vision of 140 °, 160–80 ° angulation, and a diameter of 13.8 mm; the shaft had varying degrees of flexibility [23].

Numerous auxiliary instruments to make it easier to advance the device through the entire colon, such as stiffening wires and "sliding tubes," were proposed, but none of these was able to replace fluoroscopic guidance. The guidance method available today, using a magnetic localization system (the Olympus ScopeGuide three-dimensional control system), works without X-ray exposure and is particularly useful in helping beginners to reach the cecum or terminal ileum more quickly, and for recognizing and eliminating loops and loop formation. The localization system also makes it possible to precisely locate findings for subsequent surgical interventions [24].

As a completely new method, colonoscopy immediately attracted a great deal of attention. The major diseases of the large bowel and terminal ileum, such as polyps, carcinoma, chronic inflammatory bowel diseases, infectious and ischemic colitis, were redefined and reevaluated. The advantages of direct inspection of the bowel lumen and the use of auxiliary devices and methods—such as biopsy forceps, electrical snares, coagulation probes, injection needles, chromoscopy, mucosectomy, and balloon dilation—have become evident during the last few decades. In addition to the diseases mentioned above, diverticulitis, collagenous colitis, microscopic colitis, localization and treatment of occult bleeding sources such as vascular malformations, etc., were also redefined. Removal of colonic adenomas was identified as a method of preventing colorectal carcinoma [25,26], and monitoring of chronic inflammatory bowel diseases was recognized as important for recognizing dysplasias and carcinomas as early as possible. Identifying the causes of unclear diarrhea and bleeding sources are also important indications for colonoscopy today.

In addition to Christopher Williams in England [23], the pioneers of colonoscopy include Hirohumi Niwa (Japan) [22], Bergein Overholt [15], Hiromi Shinya [27] and Jerome Waye [26] in the USA, and the innovative figures of Peter Deyhle [25] and Peter Frühmorgen in Ludwig Demling's research group in Erlangen, Germany [28]. The clinical and scientific work of V.P. Strekalovskiĭ (Moscow) is little known in Western countries.

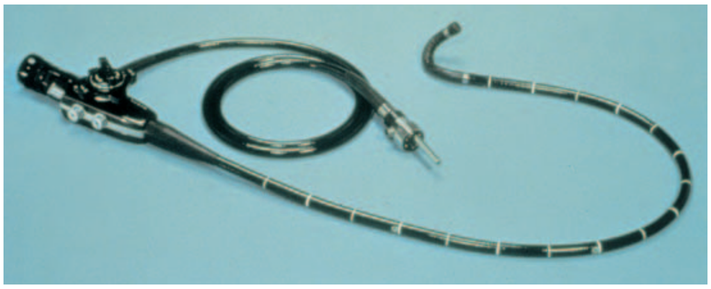


Fig. 1.10 A fiber gastroscope from the early 1970s, with omnidirectional angulation (Olympus GIF-D).

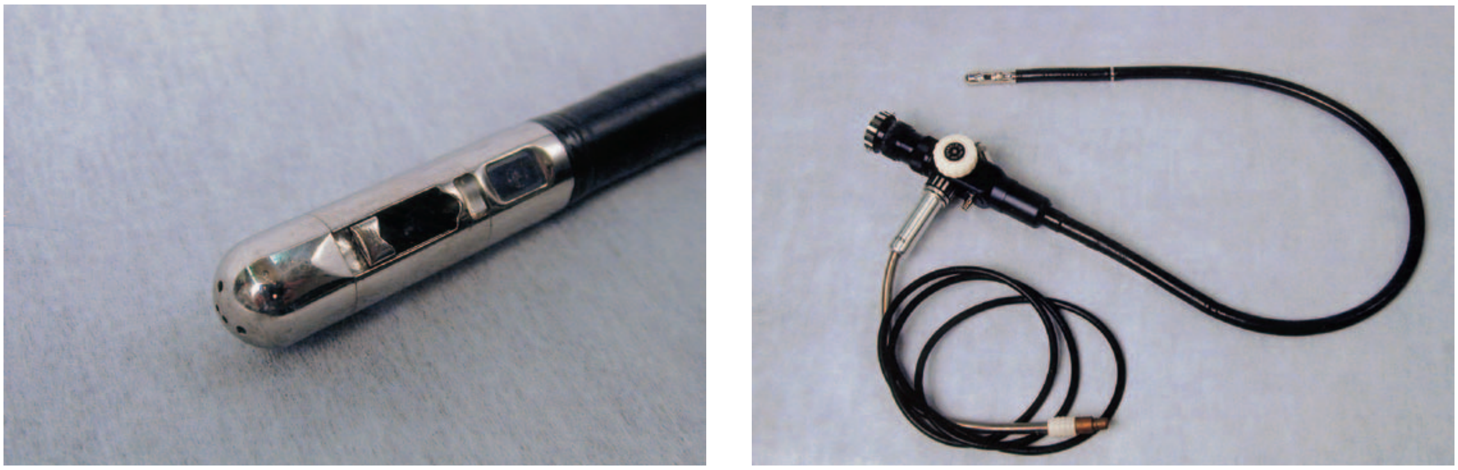
Endoscopic Retrograde Cholangiopancreatography

The Americans McCune, Shorb, and Moscovitz [29] published the first report of successful exploration of the papilla of Vater (the major duodenal papilla) and retrograde demonstration of the ductal system opening there. However, the quality of the radiographs obtained with an Eder fiberoptic duodenoscope was so poor that Ludwig Demling and I felt unable to definitely identify a cholangiopancreatography on them. Using a fiber endoscope made by the Wolf Knittlingen company, we were also only able to probe the papilla of Vater in one patient in April 1970, and instillation of contrast medium into the pancreatic duct was incomplete. It was only when the Machida and Olympus companies in 1970 offered duodenoscopes with good optical characteristics and a mechanism for omnidirectional angulation that reliable introduction of the device into the duodenum, location and intubation of the papilla of Vater, and selective intubation of the ducts became routine. The papers presented by Itaru Oi on endoscopic retrograde cholangiopancreatography (ERCP) at the World Congress for Gastroenterology and Endoscopy held in Copenhagen in 1970 were *the* sensation of the conference [30] (**Fig. 1.11a–c**, **Fig. 1.13**). For the first time, gastroenterologists were now able to reliably diagnose morphological changes caused by diseases of the hepatobiliary and pancreatic ductal systems. Our own group received a JFB-1 instrument from Olympus in November 1970, and by the end of that year we had been able to demonstrate one or both ductal systems in 16 of 20 attempts [31]. Numerous research groups all over the world did pioneering work in identifying the potentialities and risks of ERCP. Pioneers alongside Kawai and Kawajima included Ogoshi et al. [32] and Fujita et al. [33] in Japan; N. Soehendra and E. Seifert in Germany; P.B. Cotton and P. Salmon in the United Kingdom; C. Liguory in France [34]; M. Cremer in Belgium [35]; L. Safrany in Hungary; J. E. Geenen, J. Vennes, and D. Zimmon in the USA; and G.C. Caletti in Italy (see references in the relevant chapters).

In 1976, an endoscopic piggyback system (the mother-and-baby scope) for cholangioscopy was presented by Olympus Optical Co. [36]. The mother device was introduced into the duodenum, and the thin baby scope (with an outer diameter of 2 mm) was then introduced through the papilla of Vater into the bile duct for direct inspection.

Percutaneous Transhepatic Cholangiography

In 1921, Hans Burkhardt and Walter Müller (surgeons in Marburg, Germany) for the first time injected a fluid contrast medium percutaneously into the gallbladder and bile ducts [37]. In 1937, the French surgeon Pierre Husard in Hanoi and his Vietnamese colleague Do-Xuan Hop were also able to inject Lipiodol into the bile ducts via a percutaneous transhepatic route [38]. An important pioneer in this field was Kunio Okuda, who was the first to combine

a

b

c


Fig. 1.11 The Machida duodenoscope with which Itaru Oi worked—an elegant but difficult device.

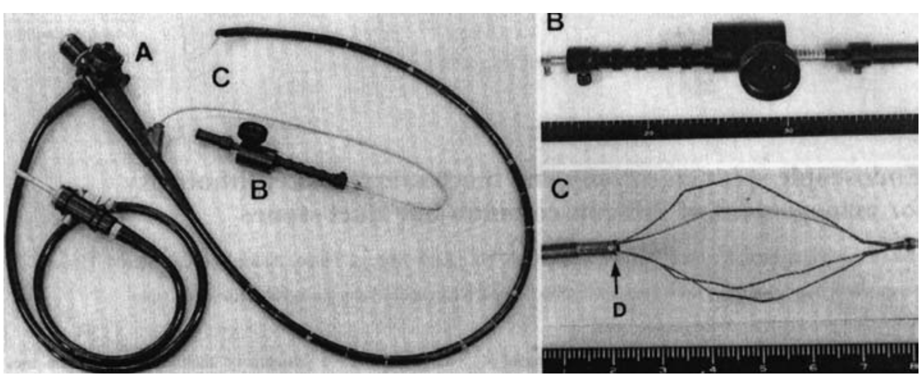


Fig. 1.12 An Olympus duodenoscope with a mechanical lithotriptor (B, C & D).

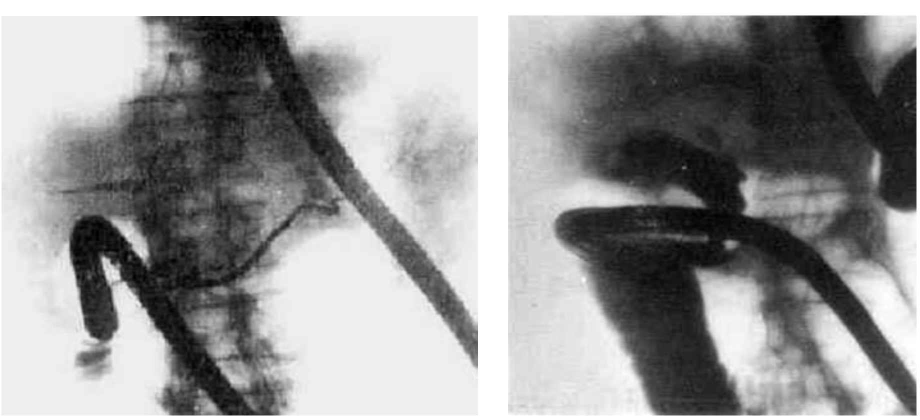


Fig. 1.13 The first images showing endoscopic retrograde cholangiopancreatography, which Itaru Oi presented at the Fourth World Congress of Gastroenterology in Copenhagen, 12–18 July 1970.

percutaneous cholangiography with external biliary drainage [39]. The Swedish surgeon Karl Ludvik Wiechel was the first to introduce percutaneous transhepatic cholangiography into more or less routine practice in Europe [40], succeeding against strong resistance.

ERCP, which entered clinical practice in 1970, did not make the percutaneous access route superfluous, as ERCP examinations (or at least complete examinations) were not possible in quite a few patients with biliary strictures, as well as in patients in whom access to the papilla of Vater was difficult. In 1975, Yamakawa et al. [41] first described the technique of percutaneous transhepatic cholangioscopy, which is still in use today. Stabilization of the puncture channel using mandrins, and subsequent enlargement of it up to 10–12 Fr in two or three steps over a period of 8–10 days, made it possible to introduce flexible cholangioscopes, which were initially equipped with fiberglass but now have charge-coupled device (CCD) chips for image transmission. This approach made it possible to carry out all of the therapeutic manipulations in the intrahepatic and extrahepatic biliary system that were difficult using the route through the papilla of Vater. These include lithotripsy (mechanical, electrohydraulic, and laser), stricture dilation, and tumor ablation.

However, the visual facilities provided by cholangioscopy were limited, illumination was poor, and breaks in the glass fibers led to reduced visibility, as did the yellow discoloring of the glass fibers caused by X-rays. By contrast, the new 1-mm thin chip endoscopes that have been available since 2003 for the same target area provide a clear view into the thin lumina.

Enteroscopy

For a long period, the small bowel stubbornly resisted every effort that was made to achieve complete inspection of it with flexible instruments. Initial attempts were made in 1972, when we managed to guide a 2-m long fiber endoscope through the entire gastrointestinal tract over a swallowed nylon thread [42]. Our efforts to inspect the small bowel remained incomplete, as there were a few regions that “raced past” the lens, and due to the nylon thread it was not always possible to distinguish definitively between superficial mucosal lesions and relevant changes. Complete visualization of the small bowel was still not possible later on, with push enteroscopy and probe enteroscopy. For intraoperative enteroscopy, it was necessary to know in advance at least the segment of the bowel in which a lesion was suspected.

Capsule endoscopy, developed by the ingenious Paul Swain and Given Imaging, Ltd., has now solved diagnostic problems in small-bowel diseases such as occult bleeding sources, tumors, and Crohn’s disease lesions that cannot be identified with other methods. It can be usefully supplemented with enteroscopy using one or two balloons, and the latter method also allows biopsies and therapeutic interventions to be carried out [43,44].

Therapeutic Endoscopy

Endoscopy only played a very minor role, if any, in gastrointestinal diagnosis before 1960, but the diagnosis and treatment of numerous digestive tract diseases would be inconceivable without it today. It would be unthinkable nowadays for a gastroenterologist not to have good endoscopic skills, including skills in therapeutic endoscopy.

Foreign-body removal from the digestive tract viscera is the oldest method in therapeutic endoscopy. As early as 1906, Hugo Starck reported on 73 cases of foreign-body extraction from the esophagus [45]. He and Jean Guisez [46] were the pioneers of the method (**Fig. 1.14**). Today, it is primarily children and prisoners who swallow foreign bodies, and as long as these remain in the upper gastrointestinal tract, including the duodenum, they can be extracted endoscopically using special auxiliary devices. Foreign bodies introduced into the rectum can also be mobilized and extracted by the endoscopist. General anesthesia and laparotomy are now only rarely needed for treatment of foreign bodies.

Esophageal dilation can now also be regarded as a method of only historical interest. The Starck dilator—a construction resembling an umbrella—was used right up to the 1970s for achalasia, as was the Gottstein balloon. Starck also popularized the method of bougienage of long esophageal strictures—e. g., strictures due to caustic injuries. Hard cicatricial strictures in the esophagus used to be incised using an endoscopically controlled esophagotome. All of these procedures were guided using a rigid esophagoscope, and this continued to be quite customary in some otorhinolaryngology departments even up to the 1990s. Gastroenterologists, by contrast, were already using fiber endoscopy for foreign-body extraction and controlled balloon dilation at the end of the 1960s [47]. The balloons that are in use today have a ring-shaped mark to allow precise endoscopic and/or fluoroscopic positioning within the stricture. Modern treatment of achalasia using botulinum toxin (Botox) is based on the principle of reducing the pressure in the lower esophagus [48].

Palliative treatment of malignant stenoses is another of the older methods in therapeutic endoscopy. Endoscopic stent treatment for stenotic esophageal tumors was developed to clinical maturity by Atkinson and Ferguson [49] and by Guido Tytgat’s group in Amsterdam [50]. The earlier plastic stents have now been replaced with self-expanding metal stents. The first description of the use of a spiral metal stent was published in 1982 by Eckart Frimberger, who was then still a member of Rudolf Ottenjann’s research group [51]. Covered metal stents with small hooks at each end are usually able to hold the metal stent in the desired position and are often also used to close esophagobronchial fistulas.

The procedure of hemostasis with palliative ablation of stenotic tumor tissue using neodymium:yttrium–aluminum–garnet (Nd:YAG) laser coagulation was originally developed by Kiefhaber et al. [52]. This method is now only rarely used, in stenoses that are barely passable.

Photodynamic diagnosis and treatment. Initial experimental treatments with fluorescent dyes were carried out as long ago as 1903 [53]. In premalignant and malignant epithelial structures, porfimer sodium (Photofrin) and Δ-aminolevulinic acid (ALA) enhance more strongly than in the normal neighboring epithelium. This characteristic can be helpful for diagnosis and targeted treatment in patients with chronic inflammatory bowel diseases, and particularly in ulcerative colitis and Barrett’s epithelium with circumscribed high-grade dysplasia/carcinomas that are difficult to recognize endoscopically. Marianne Ortner was the first to use photodynamic diagnosis and therapy in patients with biliary malignancies [54].

Endoscopic polypectomy. The origins of endoscopic polyp removal using rigid esophagoscopes and rectoscopes are difficult to trace, but certainly go back a long time. Following the introduction of fiber colonoscopy, Hirohumi Niwa in Tokyo was able in 1968 to remove colonic polyps using an isolated biopsy forceps (hot biopsy), and later using a coagulation probe. In 1969, he reported at a conference of Japanese endoscopists on the first snare polypectomies in the colon, although these were apparently unsuccessful [55]. His research was obstructed for several years when protesting students barricaded his laboratory door. The first fiber-endoscopic polypectomies in the colon were carried out by Peter Deyhle and colleagues [56] in 1970, and procedures in the stomach were reported in 1971 by our own group and Ottenjann’s group in Germany simultaneously [57,58] and by William Wolff and Hiromi Shinya in New York [59]. The importance of polypectomy in the colon as a means of preventing cancer was impressively demonstrated by Sidney Winawer and colleagues in the National Polyp Study in the USA [60].

Polypectomy significantly reduces not only the mortality from colorectal carcinomas, but also the incidence of the lesions.

Modern techniques for enlarging the endoscopic image and enhancing structures by applying stains (chromoendoscopy) are nowadays able to improve image perception and allow better classification in differentiating between surface structures that are suspicious for malignancy [61], particularly in small depressed and malignant lesions, which infiltrate the submucosa in 50% of cases. They also differ from polypoid carcinomas with regard to pathogenesis and tumor biology. The basic research carried out by Shin'ei Kudo is therefore of immense interest here [62].

Endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD). Endoscopists are nowadays undaunted by superficial and broad-based tumors, even when the lesions have already infiltrated the submucosa. Inoue and Endo [63] in Japan, as well as Soehendra's group [64] in Hamburg, can claim the merit of being the first authors to report on mucosectomy (see Chapter 30). The techniques differ, but the results are comparable. Younger endoscopists—particularly Japanese colleagues such as Yahagi—are ablating wall areas with a diameter of 10 cm or more in the esophagus, stomach, and colon using endoscopic submucosal dissection in operations lasting several hours [65]. Perforations that occasionally occur are closed by the endoscopist from inside the lumen using Endoclips, and by the laparoscopist from the serosal side. As an alternative to extensive submucosal dissection, combined laparoscopic full-thickness wall resection with endoscopic guidance is possible (see Chapter 30).

Christian Ell and his research group have recently presented a report—including what is probably the largest group of patients in the world to have received this form of treatment—impressively describing the potential of endoscopic therapy in premalignant and malignant lesions in Barrett's esophagus [66].

Drainage and endoprostheses in the bile duct. Endoscopic placement of drains in the bile duct was perfected by my former associate, Dietmar Wurbs, with an ingeniously pre-shaped probe construction [67]. Shortly afterward, Soehendra and Reynders-Frederix reported the first common bile duct stent made of plastic material [68]. These two approaches—both developed in Hamburg—for drainage of the biliary tract and pancreas have not only made ERCP, endoscopic papillotomy, and other interventions in this area safer, but have also added new indications for the treatment of biliary and pancreatic diseases to the list of indications for endoscopy. Septic cholangitis has lost its seriousness if it is treated early enough, and post-ERCP pancreatitis can be avoided more often through stenting of the pancreatic duct with a thin stent (3 Fr) made of plastic. The relevant chapters of this book describe numerous other indications for stenting through the papilla of Vater.

As in the esophagus, self-expanding metal stents are now commonplace in the palliative treatment of malignant tumors in the bile duct. Frimberger et al. can take credit for being the first to report this technique [69]. Laser therapy and radiotherapy (with the afterloading technique) for malignant stenoses [70,71] currently only have a negligible role.

Hemostasis. Massive acute hemorrhage from the upper gastrointestinal tract has presented physicians with almost insurmountable problems in every period of history [72–74]. Esophageal varices were first treated in 1939 by Crafoord and Frenkner, using sclerosing agents [75]. Sclerotherapy for esophageal varices was particularly advocated by Loren Pitcher [76], but has now been largely replaced by rubber-band ligation ("banding") [77], a form of treatment that has long been used in the treatment of hemorrhoids. The ulcers resulting after esophageal banding are smaller and heal more quickly than the ulcers produced when sclerosants are injected. In accordance with a method originally suggested by Soehendra et al., bleeding from fundic varices can be arrested by injecting an acrylic resin [78].

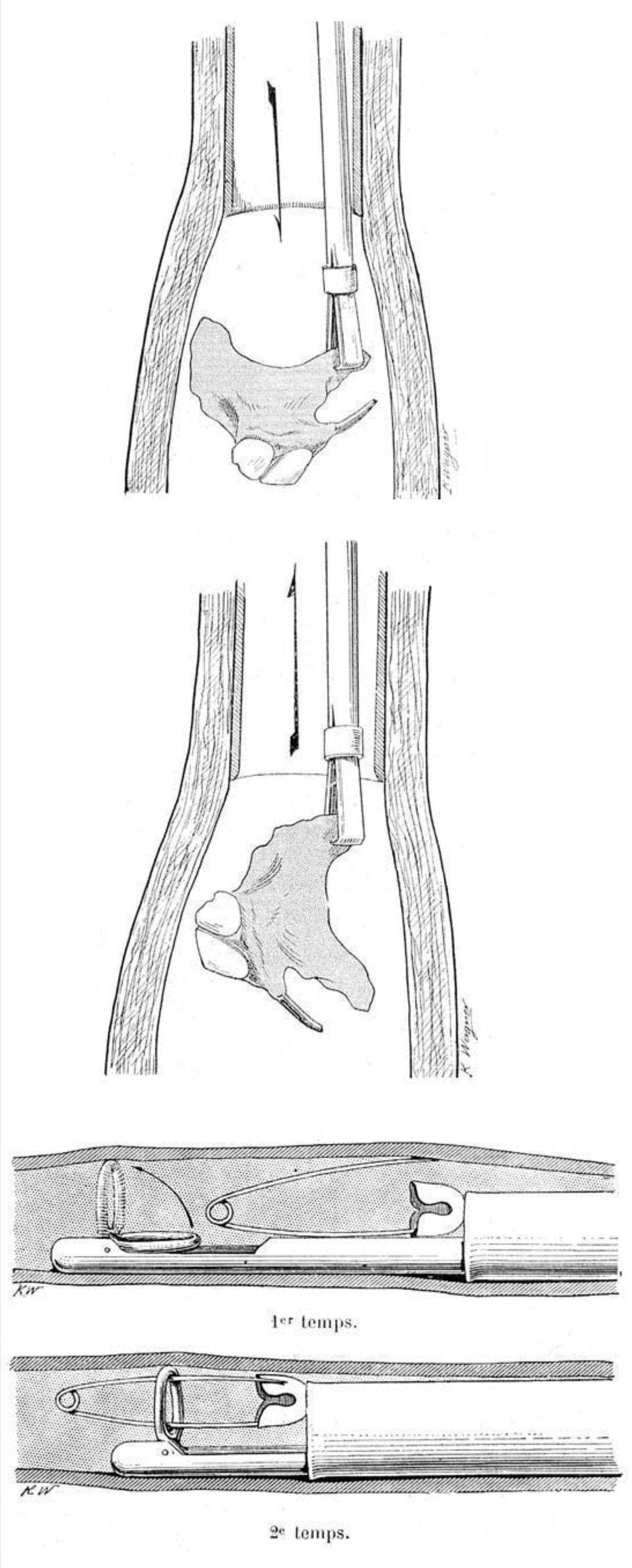


Fig. 1.14 Instructions on how to extract foreign bodies, from Jean Guisez's *Traité des maladies de l'oesophage,* 1911 [46].

The debate between the proponents of argon and Nd:YAG laser treatment for hemostasis [52,79] has long since been settled. Today, the modern argon beamer has proved its value, particularly in patients with mild bleeding and in cases of seeping hemorrhage, as well as for tissue ablation. Safe prevention or treatment of bleeding can be achieved with mechanical methods such as the Endoloop and hemoclip. The latter was already developed in the 1970s, but due to a technical problem did not gain acceptance. Experiments with endoscopic suturing machines (Heinzl, Buess) by several groups have now been resolved by Paul Swain [80,81]. The Swain model has been used to treat hiatus hernia in the context of reflux disease, and also for hemostasis.

Percutaneous endoscopic gastrostomy (PEG) was introduced by Gauderer et al. in the USA in 1980 [82]. PEG is certainly the most important method of overcoming transit disturbances for food and saliva in parts of the upper gastrointestinal tract closer to the mouth—whether the disturbances are neurogenic or caused by malignancies. If gastric dilation needs to be treated, a nutritional probe can be advanced through the gastric stoma into the jejunum. Information regarding ethical problems with PEG nutrition in patients with senile dementia and those in the terminal stages of disease is provided in Chapter 40.

Endoscopic papillotomy (EPT) and endoscopic sphincterotomy (ES, EST). Immediately after the introduction of diagnostic ERCP, the search began for a treatment approach to solve the “new diseases” for which only palliative treatment variants were available using endoscopic drainage or stenting. Even in their first approaches to the problem, Ludwig Demling and his research group started by modifying the polypectomy snare developed in Erlangen, which could be introduced without difficulty into the papilla and the ductal systems that emerge there. Electrical incision with the snare did not appear to be fully controllable endoscopically; in particular, there were concerns regarding potential trauma to the opening of the pancreatic duct, and a variant method was therefore sought. This was found in 1973 in discussions held by Ludwig Demling, particularly with Peter Frühmorgen, Hermann Bünte, and myself. Initial experiments in animals and at autopsies confirmed that the resulting instrument—known as the “Erlangen papillotome”—was practicable. It was first used in June 1973, and the procedure was successful [83]. Kawai’s research group in Kyoto pursued a different technical principle, in which an electrical knife (known as the push papillotome) is advanced into the papilla and the bile duct. Keiichi Kawai used this device in a patient for the first time in August 1973 [84]. It was subsequently found that the Erlangen papillotome was superior in terms of controllability and safety, and it is still being used throughout the world today. A miniature version of the Erlangen papillotome—which was also used for the first time by our group—may be helpful when there are anatomic variants in the ampullary orifice or in cases of stricture. The needle-knife is an important additional aid, and debate continued for several years over the indications for its use and on whether only experienced practitioners should use it or whether all endoscopists were able to do so (see Chapter 34).

Balloon dilation is an alternative to incision into the papilla of Vater, and this was first described by Staritz et al. [85]. It is now clear that anyone who carries out a dilation procedure also needs to be able to do a papillotomy.

When the length of the incision is sufficient, endoscopic papillotomy leaves a gaping common bile duct orifice and an easily recognizable pancreatic duct orifice. Endoscopists soon began to consider endoscopic treatment options for stones, parasites, inflammations, strictures, and tumors in the biliary and pancreatic ducts. Examples include mechanical lithotripsy with a reinforced Dormia basket (**Fig. 1.12**), electrohydraulic lithotripsy [86–89], laser lithotripsy [90,91], pancreatic duct stenting in chronic pancreatitis (M. Cremer), and sphincter of Oddi dyskinesia (J.E. Geenen, G. Lehman), treatment for recurrent pancreatitis in patients with pancreas divisum (P.B. Cotton), drainage [65], and bile duct stenting in patients with septic cholangitis or acute pancreatitis. As endoscopic papillotomy is a prerequisite for most endoscopic treatment methods in the bile ducts and pancreatic ductal system, it is often described as the “pattern for pancreaticobiliary procedures.”

Fig. 1.15 Ludwig Demling.

Endoscopic Ultrasonography

The method of endoscopic ultrasonography (EUS) is undoubtedly one of the greatest advances that has been made in the field of digestive tract endoscopy, as it provides the endoscopist with unrivaled visualization of the wall of the bowel with its typical layers, as well as a glimpse of the neighboring structures. Initial experiments were conducted by Wild and Reid, who introduced a mechanically rotating scanner into the rectum in 1957 [92]. The difficulties involved in introducing a scanner into the esophagus and stomach were only solved many years later. Initial clinical experience was gained in 1980 [93–95]. The “marriage” of endoscopy and ultrasound was particularly fruitful for the staging of tumors in the upper gastrointestinal tract and pancreas. EUS using a probe in the narrow lumina of the pancreas and biliary tract is known as intraductal ultrasonography (IDUS). It provides remarkably clear images. Procedures conducted using EUS guidance—such as choledochoduodenostomy, neurolysis (e. g., of the celiac plexus) and in particular cystogastrostomy and cystoenterostomy—show the growing potential of this method [96].

Laparoscopy

In 1902, Georg Kelling (1866–1945), one of the most important personalities among the pioneers of endoscopy (including esophagoscopy and gastroscopy) inspected the abdominal cavity of a dog using a cystoscope [97,98] (**Fig. 1.16**). By 1910, he had reported a few "celioscopies" using a pneumoperitoneum and port placement. In the same year, Hans-Christen Jacobaeus in Stockholm—without knowing anything of Kelling's work—described a procedure he called "laparoscopy" [99]. For decades, laparoscopy then played an important role, primarily in central Europe, in the morphological diagnosis of liver diseases and other conditions in the peritoneal cavity. Particular achievements in this area were made by Kalk et al. [100], Harald Lindner, and others. An outstanding atlas and textbook of laparoscopy by Henning et al. was produced by Thieme, the present publishers, in 1994 [101]. Minilaparoscopy for the diagnosis of abdominal emergencies and unclear findings in the liver and peritoneum is unfortunately nowadays only used in a few centers [102]. Ultrasound-guided biopsy of hepatic lesions appears to be replacing laparoscopy in internal medicine departments. Abdominal surgeons have relabeled laparoscopy-assisted treatment procedures as "minimally invasive surgery." Keyhole surgery has now progressed well beyond the areas of its initial success in appendectomy and cholecystectomy [103–107], and surgery for benign gastric and intestinal diseases has now also entered the range of indications for minimally invasive procedures. Earlier warnings against carrying out oncological procedures using the laparoscope are now no longer heeded. The present volume has for the first time grouped new types of procedure under the heading of natural orifice transluminal endoscopic surgery (NOTES). Access to the abdominal organs is achieved via the body's natural orifices (peroral, transgastric, transrectal, and transvaginal). The role of the gastroenterologist is thoughtfully outlined by Robert Hawes in Chapter 23.

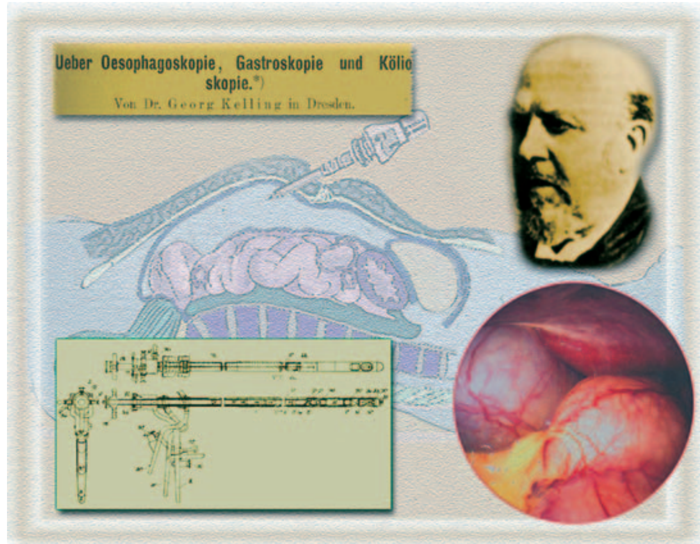


Fig. 1.16 George Kelling of Dresden and his 1902 publication.

Summary and Prospects

Forty years ago, endoscopy of the digestive tract only had a negligible role in the diagnosis and treatment of digestive diseases, with the exception of rectoscopy and laparoscopy. I would estimate that some 200 completely new diseases have since been discovered and correctly understood with regard to their etiology and pathogenesis, or have since become amenable to causal treatment. In most cases, this has been achieved with the help of endoscopy, biopsy, histology, radiology, microbiology, molecular biology, genetics, and other endoscopy-supported methods. The most outstanding example of this is the discovery of *Helicobacter pylori* and the diseases caused by the bacterium. Further examples of the tremendous importance of endoscopy include early recognition of gastrointestinal tumors and prevention of carcinoma in the colon using polypectomy. In comparison with other imaging methods, endoscopy is the diagnostic standard for most diseases of the digestive tract and bile ducts.

Not only has the professional profile of the gastroenterologist been fundamentally transformed, with a gastroenterologist nowadays having to be an endoscopist as well—the work of other specialists, such as radiologists, surgeons, pathologists, microbiologists, etc., has also changed drastically. Endoscopy of the upper and lower digestive tract has led to pathologists moving from the autopsy table to the sickbed. The diagnosis of endoscopic biopsies, including the latest molecular-genetic methods, is now the pathologist's major concern, instead of the dissection of cadavers. Early advocates of this transformation included Basil Morson, Konrad Elster, Manfred Stolte, and Cyrus Rubin. Procedures that used to be surgical ones, such as choledochotomy, polypectomy, and many other interventions, have joined the range of indications for the less traumatic field of endoscopy. The most important aspect of this reallocation of territory is the outcome for the patient, which has been substantially improved. In the future, the science of endoscopy will show even more clearly than before, and in a multitude of ways, that it can produce practical and economic advantages both for patients and for health-care funding in the management of digestive and metabolic diseases. In polypectomy, stent therapy in the biliary and pancreatic ducts, drainage and endoprostheses, stricture dilation, PEG, hemostasis, and laparoscopy-assisted treatment procedures, the advantages of endoscopy are clear—even though strict scientific proof in the form of well-planned controlled clinical studies is not always available. Another example of the immense importance of endoscopy lies in early recognition of gastrointestinal tumors and carcinoma prevention in the colon using polypectomy. In the past, diseases of the bile ducts and pancreas belonged to the field of surgery, which was associated with considerable morbidity and mortality rates. ERCP, EPT, treatment for stones, dilation, stenting and drainage were the appropriate responses provided by endoscopy. These advances were of course only possible thanks to ingenious partners among the manufacturers of endoscopes and devices, such as Dr. Karl Storz, Dr. Herbert Schubert, Dr. I. Kawahara, A. Fukami, the Machida brothers, Reinhold Wappler, Don Wilson, and many others.

Developments are sure to continue at a breathtaking pace. Even now, there is nothing prophetic in suggesting that the endoscopy capsule, which has already proved its value for small-bowel diagnosis, will also become capable of retrograde movement and will be externally controllable and able to carry out therapeutic interventions. It is already possible to use biosensors on flexible endoscopes, and optical coherence tomography (OCT) is an example of this. Molecular imaging, bioendoscopy, and optical biopsy are the key words for the new endoscopic era. The next step will be to combine various types of spectroscopy with endoscopy in order to solve the problem of how to recognize neoplasia in flat areas of inflammation—as in Barrett's esophagus or ulcerative colitis, for example. Using ingenious "beacons," it is already possible today to use fluorescence spectroscopy to depict colonic adenomas with a diameter of 50 µm in the mouse. The future is already here. I am convinced it will be at least as exciting, fascinating, and dazzling as the last 50 years.

References

1. Modlin IM. A brief history of endoscopy. Milan: MultiMed; 2000.
2. Vilardell F. Digestive endoscopy in the second millennium: from the *Lichtleiter* to echoendoscopy. Madrid: Aula Medica Ediciones/Stuttgart: Thieme; 2006.
3. Bozzini P. Der Lichtleiter, oder Beschreibung einer einfachen Vorrichtung und ihrer Anwendung zur Erleuchtung innerer Höhlen und Zwischenräume des lebenden animalischen Körpers. Stuttgart: Max-Nitze-Museum; 1988 [reprint of ed. Weimar: Verlage des Landes-Industrie-Comptoirs; 1807].
4. Kluge F. Adolf Kussmaul, 1822–1902. Arzt und Forscher—Lehrer der Heilkunst. Freiburg im Breisgau, Germany: Rombach; 2002.
5. Mikulicz J. Über Gastroskopie und Ösophagoskopie. Wien Med Press 1881; 22: 1629–31.
6. Schindler R. Gastroscopy: the endoscopic study of gastric pathology. 2nd ed. Chicago: University of Chicago Press; 1950.
7. Henning N, Keilhack H. Die gezielte Farbenphotographie in der Magenhöhle. Dtsch Med Wochenschr 1938; 64: 1392–3.
8. Hirschowitz BI. A fibre optic flexible oesophagoscope. Lancet 1963; ii (7304): 388.
9. Lamm H. Biegsame optische Geräte. Z Instrumentenkd 1930; 50: 579–81.
10. Hopkins HH, Kapany NS. A flexible fiberscope using static scanning. Nature 1954; 173: 39–41.
11. Hirschowitz BI, Curtiss LE, Peters CW. A flexible light transmitting tube. U. S. patent no. 3,010,357. Washington, DC: US Patent Office; 1961.
12. Hirschowitz BI, Curtiss LE, Peters CW, Pollard HM. Demonstration of a new gastroscope, the fiberscope. Gastroenterology 1958; 35: 50–3.
13. Ottenjann R, Petzel H. [Endogastric inversion of the fiber gastroscope for the endoscopy of the stomach fornix]. Med Klin 1966; 61: 1543–4. German.
14. Provenzale L, Revignas A. Transanale Kolonoskopie mittels Fiberoptik. Bericht einer neuen Methode zur Untersuchung des gesamten Dickdarms. In: Fortschritte der Endoskopie (2nd Conference of the Deutsche Gesellschaft für Endoskopie, Erlangen, February 1968), vol. 1. Stuttgart: Schattauer; 1969: 167.
15. Overholt BF. The history of colonoscopy. In: Hunt RH, Waye JD, editors. Colonoscopy: techniques, clinical practice, and colour atlas. London: Chapman-Hall, 1981; 1–7.
16. Classen M, Phillip J. Electronic endoscopy of the gastrointestinal tract: initial experience with a new-type endoscope that has no fiberoptic bundle for imaging. Endoscopy 1984; 16: 16–9.
17. Haubrich WS. History of endoscopy. In: Sivak MV Jr, editor. Gastroenterologic endoscopy. Philadelphia: Saunders, 1987; 2–19.
18. Sivak MV Jr, Fleischer DE. Colonoscopy with a video endoscope: preliminary experience. Gastrointest Endosc 1984; 30: 1–5.
19. Lange F, Meltzing CA. Die Photographie des Mageninneren. Münch Med Wochenschr 1898; 50: 1585–8.
20. Uji T. The gastrocamera. Tokyo Med J 1952; 61: 135–8.
21. Von Gaisberg U. Bedeutung der Gastrocamera. Stuttgart: Edition Medi-Text; 2005.
22. Niwa H, Fujino M, Yoshitoshi Y. Colonic fiberscopy for routine practice. In: Advances in gastrointestinal endoscopy: proceedings of the Second Congress of the International Society of Gastrointestinal Endoscopy, Rome, July 1972). Padua, Italy: Piccin Medical, 1972; 549–55.
23. Williams C, Muto T. Examination of the whole colon with fibreoptic colonoscope. Br Med J 1972; 3: 278–81.
24. Olympus Europe Medical Systems and Endoscopy [Internet]. Hamburg, Germany: Olympus Europa, Ltd.; 2009. ScopeGuide: new imaging technique for colonoscopy. Available from: http://www.olympus-europa.com/endoscopy/431_ScopeGuide.htm. Accessed 12 March 2009.
25. Deyhle P, Demling L. Coloscopy: technique, results, indication. Endoscopy 1971; 3: 143–51.
26. Waye J. Colonoscopy. Surg Clin North Am 1972; 52: 1013–24.
27. Wolff WI, Shinya H. Colonofiberoscopy. JAMA 1971; 217: 1509–12.
28. Demling L, Classen M, Frühmorgen P, editors. Atlas of enteroscopy: endoscopy of the small and large bowel, retrograde cholangio-pancreatography. Berlin: Springer; 1974.
29. McCune WS, Shorb PE, Moscovitz H. Endoscopic cannulation of the ampulla of Vater: a preliminary report. Ann Surg 1968; 167: 752–6.
30. Oi I, Kobayashi S, Kondo T. Endoscopic pancreatocholangiography. Endoscopy 1970; 2: 103.
31. Demling L, Classen M. Duodenojejunoscopy. Endoscopy 1970; 2: 115–7.
32. Ogoshi K, Tobita Y, Hara Y. Endoscopic observation of the duodenum and endoscopic pancreatocholangiography. Gastroenterol Endosc 1970; 12: 83–94.
33. Fujita R, Sohma S, Kidokoro T. Endoscopy of the duodenum (experience using Olympus JF-2). Gastroenterol Endosc 1970; 12: 97–106.
34. Liguory C, Meduri B, Coelho F, Ahl-Kampf C, Leger L. Traitement endoscopique d'un faux kyste sur pancréas divisum. Chirurgie 1982; 108: 273–8.
35. Cremer M, Devière J, Delhaye M, Baize M, Vandermeeren A. Stenting in severe chronic pancreatitis: results of medium-term follow-up in 76 patients. Endoscopy 1991; 23: 171–6.
36. Nakajima M, Akasaka Y, Fukumoto K, Misuyoshi Y, Kawai K. Peroral cholangiopancreatoscopy (PCPS) under duodenoscopic guidance. Am J Gastroenterol 1976; 66: 241–7.
37. Burckhardt H, Müller W. Versuche über die Punktion der Gallenblase und ihre Rötngendarstellung. Dtsch Z Chir 1921; 162: 168–97.
38. Huard P, Do XH. La ponction transhépatique des canaux biliaires. Bull Soc Méd Chir Indoch 1937; 28: 1090–100.
39. Okuda K, Tanikawa K, Emura S, et al. Nonsurgical percutaneous transhepatic cholangiography diagnostic significance in medical problems of the liver. Dig Dis 1974; 19: 21–7.
40. Sandberg AA. Karl Ludwig Wiechel. Profiler svensk kirurgi. Sven Kir 2008; 66: 6.
41. Yamakawa T, Komaki F, Shikata JI. Biliary tract endoscopy with an improved choledochofiberscope. Gastrointest Endosc 1978; 24: 110–3.
42. Classen M, Frühmorgen P, Koch H, Demling L. Peroral enteroscopy of the small and large intestine. Endoscopy 1972; 4: 157–62.
43. Iddan G, Meron G, Glukhovsky A, Swain P. Wireless capsule endoscopy. Nature 2000; 405: 417.
44. May A, Nachbar L, Wardak A, Yamamoto H, Ell C. Double-balloon enteroscopy: preliminary experience in patients with obscure gastrointestinal bleeding or chronic abdominal pain. Endoscopy 2003; 35: 985–91.
45. Starck H. Lehrbuch der Ösophagoskopie, 2nd ed. Würzburg, Germany: Kabitsch; 1914.
46. Guisez J. Traité des maladies de l'oesophage. Paris: Baillière, 1911.
47. Witzel L. Treatment of achalasia with a pneumatic dilator attached to a gastroscope. Endoscopy 1981; 13: 176–7.
48. Storr M, Born P, Frimberger E, Weigert N, Rösch T, Meining A, et al. Treatment of achalasia: the short-term response to botulinum toxin injection seems to be independent of any kind of pretreatment. BMC Gastroenterol 2002; 2: 19.
49. Atkinson M, Ferguson R. Fibreoptic endoscopic palliative intubation of inoperable oesophagogastric neoplasms. Br Med J 1977; 1: 266–7.
50. Tytgat GNJ, den Hartog Jäger FCA, Haverkamp HJ. Positioning of a plastic prosthesis under fiberendoscopic control in the palliative treatment of cardio-esophageal cancer. Endoscopy 1976; 8: 180–5.
51. Frimberger E. Expanding spiral—a new type of prosthesis for the palliative treatment of malignant esophageal stenoses. Endoscopy 1983; 15 (Suppl 1): 213–4.
52. Kiefhaber P, Nath G, Moritz K. Endoscopical control of massive gastrointestinal hemorrhage by irradiation with a high-power Neodymium-Yag laser. Prog Surg 1977; 15: 140–55.
53. Tappeiner HV, Jesionck A. Therapeutische Versuche mit fluoreszierenden Farbstoffen. Münch Med Wochenschr 1903; 1: 2042.
54. Ortner ME, Caca K, Berr F, Liebetruth J, Mansmann U, Huster D, et al. Successful photodynamic therapy for nonresectable cholangiocarcinoma: a randomized prospective study. Gastroenterology 2003; 125: 1355–63.
55. Niwa H. Endoscopic polypectomy using high-frequency current. [Paper presented at the Eighth Kanto Branch Meeting of the Japanese Gastroenterological Endoscopy Society.]
56. Deyhle P, Seibarth K, Jenny S, Demling L. Endoscopic polypectomy in the proximal colon. Endoscopy 1971; 3: 103–5.
57. Classen M, Demling L. Operative Gastroskopie: Fiberendoskopische Polypenabtragung im Magen. Dtsch Med Wochenschr 1971; 37: 1466–7.
58. Rösch W, Elster K, Ottenjann R. [Endoscopic and biopsy diagnosis of stomach polyps]. Dtsch Med Wochenschr 1971; 96: 39–40. German.
59. Wolff WI, Shinya H. Polypectomy via the fiberoptic colonoscope. Removal of neoplasms beyond reach of the sigmoidoscope. N Engl J Med 1973; 288; 329–32.
60. Winawer SJ, Zauber AG, Ho MN, O'Brien MJ, Gottlieb LS, Sternberg SS, et al. Prevention of colorectal cancer by colonoscopic polypectomy. The National Polyp Study Workgroup. N Engl J Med 1993; 329: 1977–81.
61. Niwa H. The history of digestive endoscopy. In: Niwa H, Tajiri H, Nakajima M, Yasuda K, editors. New challenges in gastrointestinal endoscopy. Tokyo: Springer, 2008; 3–28.
62. Kudo S. Early colorectal cancer: detection of depressed types colorectal carcinomas. Tokyo/New York: Igaku Shoin; 1996.
63. Inoue H, Endo M. Endoscopic esophageal mucosal resection using a transparent tube. Surg Endosc 1990; 4: 198–201.

64. Soehendra N, Binmoeller KF, Bohnacker S, et al. Endoscopic snare mucosectomy in the esophagus without any additional equipment: a simple technique for resection of flat early cancer. Endoscopy 1997; 29: 380–3.
65. Yahagi N. Is esophageal endoscopic submucosal dissection an extreme treatment modality, or can it be a standard treatment modality? Gastrointest Endosc 2008; 68: 1073–5.
66. Manner H, May A, Pech O, et al. Early Barrett's carcinoma with "low-risk" submucosal invasion: long-term results of endoscopic resection with a curative intent. Am J Gastroenterol 2008; 103: 2589–97.
67. Wurbs D, Dammermann R, Classen M. [Palliative non-surgical bile duct drainage]. Dtsch Med Wochenschr 1979; 104: 1831–2. German.
68. Soehendra N, Reynders-Frederix V. [Palliative biliary duct drainage. A new method for endoscopic introduction of a new drain]. Dtsch Med Wochenschr 1979; 104: 206–7. German.
69. Frimberger E, Kühner W, Ottenjann R. [Spiral prosthesis for the common bile duct]. Dtsch Med Wochenschr 1982; 107: 1985–6. German.
70. Phillip J, Hagenmüller F, Manegold K, Szepesi S, Classen M. [Endoscopic intraductal radiotherapy of high bile-duct carcinoma]. Dtsch Med Wochenschr 1984; 109: 422–6. German.
71. Hagenmüller F, Sander C, Sander R, Ries G, Classen M. Laser and endoluminal 192-iridium radiation. Endoscopy 1987; 19 (Suppl 1): 16–8.
72. Pitcher JL. Therapeutic endoscopy and bleeding ulcers: historical overview. Gastrointest Endosc 1990; 36 (Suppl 5): S 2–7.
73. Desneux JJ. [Emergency endoscopy in acute digestive hemorrhages]. Arch Mal Appar Dig Mal Nutr 1958; 47: 1163–8. French.
74. Palmer ED. The vigorous diagnostic approach to upper-gastrointestinal tract hemorrhage. A 23-year prospective study of 1,400 patients. JAMA 1969; 207: 1477–80.
75. Crafoord C, Frenckner P. New surgical treatment of varicous veins of the oesophagus. Acta Otolaryngol 1939; 27: 422–9.
76. Pitcher JL. Medical management of bleeding esophagogastric varices. In: Bárány FR, Torsoli A, editors. Gastrointestinal emergencies: proceedings of the First International Symposium held at the Wenner-Gren Center, Stockholm, September 1975. Oxford: Pergamon Press, 1977; 261–8.
77. Van Stiegmann G, Cambre T, Sun JH. A new endoscopic elastic band ligating device. Gastrointest Endosc 1986; 32: 230–3.
78. Soehendra N, Nam VC, Grimm H, Kempeneers J. Endoscopic obliteration of large esophagogastric varices with bucrylate. Endoscopy 1986; 18: 25–6.
79. Frühmorgen P, Bodem F, Reidenbach HD, Kaduk B, Demling L. Endoscopic laser coagulation of bleeding gastrointestinal lesions with report of the first therapeutic application in man. Gastrointest Endosc 1976; 23: 73–5.
80. Gong F, Swain P, Kadirkamanathan S, et al. Cutting thread at flexible endoscopy. Gastrointest Endosc 1996; 44: 667–74.
81. Swain CP. New technology for diagnostic and therapeutic endoscopy. In: Classen M, Tytgat GNJ, Lightdale CJ, editors. Gastroenterological endoscopy. Stuttgart: Thieme; 2002: p. 62–70.
82. Gauderer MW, Ponsky JL, Izant RJ Jr. Gastrostomy without laparotomy: a percutaneous endoscopic technique. J Pediatr Surg 1980; 15: 872–5.
83. Classen M, Demling L. [Endoscopic sphincterotomy of the papilla of Vater and extraction of stones from the choledochal duct]. Dtsch Med Wochenschr 1974; 99: 496–7. German.
84. Kawai K, Akasaka Y, Murakami K, Tada M, Koli Y. Endoscopic sphincterotomy of the ampulla of Vater. Gastrointest Endosc 1974; 20: 148–51.
85. Staritz M, Ewe K, Meyer zum Büschenfelde KH. Endoscopic papillary dilation (EPD) for the treatment of common bile duct stones and papillary stenosis. Endoscopy 1983; 15: 197–8.
86. Riemann JF, Demling L. Lithotripsy of bile duct stones. Endoscopy 1983; 15 (Suppl 1): 191–6.
87. Nakajima M, Yasuda K, Cho E. Endoscopic sphincterotomy and mechanical basket lithotripsy for management of difficult common bile duct stones. J Hepatobiliary Pancreat Surg 1997; 4: 5–10.
88. Frimberger E, Kühner W, Weingart J, Ottenjann R. [A new method of electrohydraulic cholelithotripsy (lithoklasia)]. Dtsch Med Wochenschr 1982; 107: 213–5. German.
89. Koch H, Rösch W, Walz V. Endoscopic lithotripsy in the common bile duct. Gastrointest Endosc 1980; 26: 16–8.
90. Lux G, Ell C, Hochberger J, Müller D, Demling L. The first successful endoscopic retrograde laser lithotripsy of common bile duct stones in man using a pulsed neodymium-YAG laser. Endoscopy 1986; 18: 144–5.
91. Neuhaus H, Hoffmann W, Gottlieb K, Classen M. Endoscopic lithotripsy of bile duct stones using a new laser with automatic stone recognition. Gastrointest Endosc 1994; 40: 708–15.
92. Wild JJ, Reid JM. Diagnostic use of ultrasound. Br J Phys Med 1956; 19: 248–57.
93. Strohm WD, Phillip J, Hagenmüller F, Classen M. Ultrasonic tomography by means of an ultrasonic fiberendoscope. Endoscopy 1980; 12: 241–4.
94. DiMagno EP, Buxton JL, Regan PT, et al. Ultrasonic endoscope. Lancet 1980; 1: 629–31.
95. Hisanaga K, Hisanaga A, Nagata K, Ichie Y. High speed rotating scanner for transgastric sonography. AJR Am J Roentgenol 1980; 135: 627–9.
96. Hawes RH, van Dam J, Varadarajulu S, editors. Diagnostic and interventional endoscopic ultrasound: 16th International Symposium on Endoscopic Ultrasonography, September 12–13, 2008, San Francisco, California. Gastrointest Endosc 2009; 69 (2 Suppl): S 1–S 266 [special issue].
97. Kelling G. Über Oesophagoskopie, Gastroskopie und Kölioskopie. Münch Med Wochenschr 1902; 49: 21.
98. Kelling G. Endoskopie für Speiseröhre und Magen. Münch Med Wochenschr 1898; 50: 1591–5.
99. Jacobaeus HC. Über Laparo- und Thorakoskopie bei Untersuchung seröser Höhlungen anzuwenden. Münch Med Wochenschr 1910; 58: 2090–2.
100. Kalk H, Wildhirt E, Burgmann W. Lehrbuch und Atlas der Laparoskopie und Leberpunktion. Stuttgart: Thieme; 1962.
101. Henning HI, Lightdale CJ, Look D. Color atlas of diagnostic laparoscopy. New York: Thieme Medical; 1994.
102. Helmreich-Becker I, Meyer zum Büschenfelde KH, Lohse AW. Safety and feasibility of new minimally invasive diagnostic laparoscopy technique. Endoscopy 1998; 30: 756–62.
103. Semm K. Endoscopic appendectomy. Endoscopy 1983; 15: 59–64.
104. Mühe E. Die erste Cholezystektomie durch das Laparoskop. Langenbecks Arch Chir 1986; 369: 804–6.
105. Mouret PH. From the first laparoscopic cholecystectomy to the frontiers of laparoscopic surgery: the future perspectives. Dig Surg 1991; 8: 124–5.
106. Dubois F, Berthelot G, Levard H. [Cholecystectomy by coelioscopy]. Presse Méd 1989; 18: 980–2. French.
107. Perissat J, Collet D, Belliard R. Gallstones: laparoscopic treatment—cholecystectomy, cholecystostomy, and lithotripsy. Our own technique. Surg Endosc 1990; 4: 1–5.

2 Quality Assurance

Anthony T. R. Axon

Introduction

In recent years, quality assurance has become an integral part of health-care provision. This has arisen in response to demands from health-care purchasers, providers and staff, and more particularly as a result of increasing patient expectations.

Patients undergoing digestive endoscopy have a right to understand why the procedure is necessary, what it will entail, and what alternatives there are. They must be aware of the risks they will be taking and must be assured that the examination will be performed in an efficient and well-run department by qualified personnel with experience and a good track record. Patients expect to be treated politely and with consideration shown both to themselves and to the relatives and friends who accompany them. After the procedure, they expect the findings to be discussed with them without delay, their follow-up to be organized efficiently, and to return home safely with advice on how to seek emergency assistance if required.

Quality assurance in endoscopy is designed to ensure that examinations are carried out to the accepted current standard. If applied properly with regular auditing, this leads to continued improvement in the quality of the service provided. This is to the advantage not only of the patient, whose experience is by far the most important aspect, but also of health-care purchasers, providers, and health-care workers as well.

History of Quality Assurance

The Emperor Augustus (63 BC–14 AD) said, "I found Rome built of bricks; I leave her clothed in marble" [1]. Quality was an important concept in the ancient world. The skills employed by the Roman builders in the construction of public buildings and civil engineering can still be seen today in monuments that testify to the quality of their workmanship. Throughout the history of civilization, governments have employed inspectors to ensure that major projects were carried out to specification. In the Middle Ages, trade guilds were set up to protect both craftsmen and the public by ensuring that only those who had served an apprenticeship could become master tradesmen and charge at the appropriate rate. Nevertheless, for most articles purchased or services received, there was no guarantee and it was a case of "buyer beware."

The Industrial Revolution led to the employment of less skilled workers in factories. In order to maintain quality standards, they worked under the supervision of a foreman. During the First World War, governments employed inspectors in the munitions factories to encourage better-quality products.

Modern quality assurance began in the USA in the 1930s, when "statistical quality control" was established on production lines. Following the Second World War, quality control was introduced into Japan by the Americans in order to help rebuild the country's industrial base. It was this that led to quality assurance—a concept based not just on following specifications laid down by an employer, but also on taking customer feedback into account. As a result, Japanese industry flourished during the 1970s. Quality assurance expanded to encompass employee education and working conditions, when it became recognized that employee satisfaction was essential for producing high-quality products.

Quality assurance in medicine has taken longer to develop. In England, the Royal College of Physicians was established in 1517, but practitioners belonging to the College largely practiced in the upper echelons of society. The Society of Apothecaries (founded as an offshoot from the Society of Grocers in 1617) provided the medical care available to most of the population. The Company of Barber-Surgeons formed in 1540 from the union of the Fellowship of Surgeons and the Company of Barbers. This partnership remained uneasy until in 1745, the surgeons broke away and formed a separate Company of Surgeons. In 1800, the Company of Surgeons was granted a Royal Charter and became The Royal College of Surgeons in London, later of England. These organizations restricted membership of the guild or college on the basis of an individual's educational training. During the 18th century, a visit to the "quack doctor" was also a social event (**Fig. 2.1**).

During the 19th and 20th centuries, medicine became scientific. Medical practitioners were obliged to obtain a license to practice, but having done so they had a free hand to practice as they wished (although their licence could be withdrawn if they practiced unethically). Specialist registration was not introduced in the United Kingdom until the 1970s. Since then, with the rapid advances in new and specialized medical, diagnostic, and therapeutic techniques, there have been radical changes in health care. Its costs have increased exponentially, medicine has become politicized, litigation has increased, and most of all patients' expectations have soared.

In the 1970s and early 1980s, the concept of medical auditing was introduced. Medical audits were aimed at assessing outcomes such as mortality, drug expenditure, and complications of surgery. Identifying the reasons why mortality or complications occurred, or why drug expenditure was high, made it possible to establish guidelines to rectify problems. The auditing loop was closed by repeating the audit at a later date and if necessary modifying the guidelines in the light of the new audit.

Fig. 2.1 Quality assurance in medicine. William Hogarth (1697–1764), *Marriage à la Mode, 3: The Inspection,* also known as *The Visit to the Quack Doctor* (ca. 1743; © The National Gallery, London).

Auditing drew attention to the variability of medical practice between one institution and another. A highly publicized investigation into excessive mortality in children undergoing heart surgery at Bristol Royal Infirmary in England during the years 1983–1995 revealed that no mechanisms were in place to identify problems automatically. These concerns, allied with the rapidly increasing cost of health care, led health contractors and patients to demand reassurance about the effectiveness of interventions and the standard of care. It became apparent that the only way to prevent inadequate practice was to introduce some form of quality assurance.

Quality Assurance in Endoscopy

Quality assurance involves setting a standard of care and ensuring that it is maintained. Health care can be divided into the elements of structure, process, and outcome [2]. In the case of endoscopy, examples of structure would include the endoscopy unit, equipment, and staff; the process would be the actual endoscopic procedure; and the outcome would be the change in health status resulting from the endoscopic procedure. Quality assurance therefore needs to address all three aspects; good structure will increase the likelihood of a good process, and a good process the likelihood of a good outcome. It is essential to place the patient at the center of quality assurance. This involves assessment and quantification of the clinical quality of the procedure provided for the patient, and also the quality of the patient's experience itself.

The next step is to consider what to measure when assessing quality. "Indicators" known to reflect the quality of care are required. Once these have been identified, a minimum standard can be set and performance can be measured against it. Failure to reach such a standard would demonstrate a poor quality of care and would result in action being taken to improve practice [3].

Quality Indicators

The measurement of quality in endoscopy has been addressed in detail by a working party of the American Society of Gastrointestinal Endoscopy (ASGE) and the American College of Gastroenterology [4]. The resulting recommendations are available free of charge on the ASGE web site (www.asge.org). The task force produced a comprehensive and practical approach to quality indicators. The report includes a general introduction applicable to all gastrointestinal endoscopic procedures and then deals individually with esophagogastroduodenoscopy, colonoscopy, endoscopic retrograde cholangiopancreatography (ERCP), and endoscopic ultrasonography. Recommendations are graded according to the quality of evidence in the literature that supports the various recommendations—ranging at best from grade 1A, where there is a clear benefit supported by randomized trials without important limitations and leading to a strong recommendation that can be applied to most clinical settings; down to grade 3, where the clarity of benefit is unclear, the evidence is based on expert opinion only, and the implication of the recommendation is weak and likely to change as further data become available.

Table 2.1 Preprocedural quality indicators

- Patient demographics
- Indication
- Timeliness
- Consent
- Clinical status and risk assessment
- Special precautions
- Sedation plan
- Team pause ("time out")

Preprocedural Quality Indicators

Quality indicators in digestive endoscopy can be broadly divided into three aspects: preprocedural, intraprocedural, and postprocedural. **Table 2.1** sets out the general preprocedural quality indicators based on the recommendations made by the American working party. Most of these indicators form part of the written endoscopy report.

Indication for Endoscopy

The indication for the procedure must be stated. An endoscopic examination will generally be undertaken only if the potential findings are likely to influence the management of the patient. Endoscopy is contraindicated when the risks of the procedure outweigh its potential benefit, or when the patient, having been fully informed of the advantages and disadvantages of the procedure, decides against having it done. There is a gray area in which the benefits of endoscopy are marginal, or when the cost or inconvenience of the procedure may outweigh the benefit. A number of authorities have made recommendations regarding which clinical situations merit endoscopy and which do not [5,6], but it is not unusual for significant pathology to be identified in a proportion of patients who would fall into the "inappropriate" group [7–9]. National guidelines on indications cannot necessarily be applied in other countries, as the epidemiology of diseases, the facilities available, and prosperity vary from country to country.

Timeliness

The timeliness of the procedure is of importance; patients usually expect a diagnosis without delay. Timeliness must be judged in relation to the indication—for example, a patient presenting with melena will require a more urgent endoscopy than one with dyspeptic pain.

Informed Consent

The issue of informed consent has assumed considerable importance in recent years [10]. Patients in most developed countries today expect to receive a full explanation as to why they require an endoscopy, what it will involve, how much it will cost, the risks it will entail, and how complications would be managed. They should also be aware of what alternative investigations could be used and when the procedure can be carried out. Each patient should receive an easily understood information sheet to take home. Ideally, unless it is an emergency procedure, the patient should sign the consent form at a later date, after they have had time to reflect and if necessary discuss it with friends, relations, or other professionals. The form should not be signed in the endoscopy suite just before the procedure takes place.

Preliminary Assessment

Before the endoscopy procedure, the patient's health status should be assessed, the American Society of Anesthesiology (ASA) score should be recorded (**Table 2.2**), and any potential risks should be noted—for example, whether antibiotic prophylaxis is needed or whether advice should be given to the examiner regarding the patient's anticoagulation treatment or diabetes. Special precautions may be needed, such as avoidance of latex rubber gloves. The patient may have drug allergies, or in those with sleep apnea it may be necessary to have an anesthetist in attendance. A sedation plan should be drawn up and discussed with the patient so that he or she is aware of what will take place.

Team Pause

The American guidelines suggest that before sedation is administered or the endoscope is inserted, a pause should be observed and documented, during which the team are clear that they have the correct patient and that the appropriate procedure will be done, and to reassess any other data that might influence the endoscopy procedure.

Intraprocedural Quality Indicators

Table 2.3 shows the intraprocedural quality indicators for EGD. Quality indicators vary according to which procedure is being performed.

Monitoring

All patients require monitoring of some kind. For those receiving sedation, intravenous access is essential, pulse oximetry and oxygen saturation is now standard, and most units monitor blood pressure. Electrocardiography may be necessary in certain patients.

Drugs and Sedation

Any medication given must be documented. It is helpful for the nursing staff to record the degree of sedation and any discomfort experienced by the patient or lack of cooperation. These data can be linked to the amount of sedation given to the patient and may lead to the conclusion that an endoscopist is either using too much or too little sedation, or possibly the endoscopic technique requires improvement.

Recordings

A photographic record of the procedure should be made. In some units, a video of the examination is retained. The timing of the procedure is valuable, particularly in colonoscopy, where the time taken to reach the cecum may provide some assessment of the examiner's endoscopic skill, whilst—perhaps more importantly—the time to extubation, if not long enough, may lead to a smaller harvest of polyps.

Postprocedural Quality Indicators

Table 2.4 sets out the quality indicators for the postprocedural period.

Discharge Criteria

An in-house protocol should be in place setting out the discharge criteria for patients. These should be documented at discharge, and the patient should be provided with written instructions as to what to do in the immediate post-discharge period. The patient must be informed about the follow-up arrangements and when pathology results will become available.

Table 2.2 American Society of Anesthesiology (ASA) score

Class	Findings
I	Healthy patients
II	Mild systemic disease, no functional limitations, no acute problems (e. g., controlled hypertension, mild diabetes)
III	Severe systemic disease, definite functional limitation (e. g., brittle diabetic, frequent angina, myocardial infarction)
IV	Severe systemic disease with acute, unstable symptoms (e. g., myocardial infarction within last 3 months, congestive heart failure, acute renal failure, uncontrolled active asthma)
V	Severe systemic disease with imminent risk of death

Table 2.3 Intraprocedural quality indicators recorded for esophagogastroduodenoscopy

- Instruments
- Monitoring
- Medication
- Completeness of examination
- Location of Z line
- Findings
- Photographic record
- Procedure time
- Patient discomfort
- Endoscopic therapy given
- Outcome
- Biopsies taken
- Complications

Table 2.4 Postprocedural quality indicators

- Predetermined discharge criteria
- Written instructions for patient
- Pathology results
- Follow-up
- Report
- Complications
- Patient satisfaction
- Communication with referring clinician
- Postprocedural drug treatment

The Report

The endoscopy report is the most important part of the quality assurance exercise, as it contains most of the information that will be required for analysis. It should include the patient's name and demographic details, the name of the referring clinician, and the indication for the procedure. The patient's ASA grade should be recorded, together with the nature and amount of sedation given and the instrument used for the examination. Any peculiarities or difficulties experienced in the procedure should be noted. In the case of colonoscopy, the quality of bowel preparation should be indicated. Then the extent of the procedure should be described—for example, whether the cecum was reached or the ileum. Any abnormalities identified should be described, along with the procedures undertaken—specifically, whether biopsies were taken and if so, from where and what number. Complications are recorded, as well as the use of any additional sedation or reversal agents.

Specific quality indicators collected by the nursing staff, such as the degree of sedation, discomfort, and pre-assessment and post-

Table 2.5 Intraprocedural quality indicators for endoscopic retrograde cholangiopancreatography (ERCP; in addition to those given in Table 2.2)

- Assessment of procedural difficulty
- Cannulation success
- Use of precut
- Size and number of biliary stones
- Stone clearance success
- Extraction technique used
- Stent placement
- Clinical success rate

Table 2.6 Intraprocedural quality indicators in colonoscopy (in addition to those given in Table 2.2)

- Quality of bowel preparation
- Cecal intubation
- Small-bowel intubation
- Number of polyps detected
- Number of polyps retrieved
- Size of polyps
- Time to cecum
- Withdrawal time

assessment details should be recorded separately by nursing staff and included in the computerized report.

Discharge

A letter should be despatched to the referring clinician indicating the findings of the endoscopy. The staff responsible for discharging the patient must be certain that the patient is fully appraised of any change in medication that is to take place after the endoscopy, such as restarting anticoagulant treatment. Patients should be provided with an emergency phone number, so that if there are any problems they can access medical advice after leaving the endoscopy unit.

Patient Satisfaction

Information should be gathered about patient satisfaction. This is usually done by encouraging patients to complete a questionnaire. The number of patients who respond is limited, and it is difficult to know how much confidence can be attached to these results. There are similar issues with late complications. Prospective studies identify more complications than those obtained retrospectively or by questionnaire. Inability to record accurately patients' views and any complications that occur is a serious drawback in assessing patient satisfaction.

It is beyond the scope of this chapter to discuss in detail all of the quality indicators for each type of procedure, but suggested intraprocedural indicators for ERCP and colonoscopy are listed in **Tables 2.5** and **2.6**, and the American guidelines mentioned above can be consulted.

Nursing Involvement in Quality Assurance

Quality assurance is a team activity. It involves the director of the endoscopy unit, the nurse in charge, the nursing staff, the hospital administration, secretarial and reception staff, and those responsible for cleaning and maintenance of the department. However, documentation of the quality indicators rests mainly with the medical and nursing staff, who are largely responsible for the preliminary assessment, intraprocedural monitoring, and postprocedural assessment.

Other areas besides the procedure itself require quality control. These include tracking of the equipment used, cleaning and disinfection of endoscopic equipment, and auditing of these processes. Ordering of equipment and inventory maintenance are necessary for the smooth and efficient running of an endoscopy unit.

Staff Safety and Satisfaction

Staff safety, efficient and personalized rostering, the provision of changing facilities, showers, and access to refreshment all encourage a happy working environment. Nursing staff often regard the quality of their working time and in particular their hours of work and scheduling as more important than the level of their salary, so it is incumbent upon those in charge of endoscopy units to ensure that working conditions are as good as they possibly can be in order to retain experienced staff and thereby provide a better-quality service.

How Should Quality Indicators Be Recorded?

Most of the quality indicators discussed above will be recorded routinely in the endoscopy report. For the purposes of quality assurance, however, it is essential that all relevant quality indicators for a particular procedure should be included.

In colonoscopy, the quality of the bowel preparation, the amount of sedation given, the colonoscopist's expertise, the time spent reaching the cecum and during withdrawal, the number of polyps identified, and instruments used are all interrelated. If these comprehensive data are not available and cannot be analyzed, the cause of a poor outcome by an endoscopist or by an endoscopy unit cannot be identified.

The incidence of bleeding, perforation, and pancreatitis in ERCP may be related to the skill of the operator, the time taken to do the procedure, the patient's age, gender, and indication, and the use of the needle precut technique. Unless all of these indicators can be analyzed, the reason why an individual examiner has a higher incidence of postprocedural pancreatitis may not be apparent. The purpose of continued quality improvement is to identify areas in which individual endoscopists or units can improve their outcomes, so complete data collection is necessary and the ability to analyze the data is critical.

Quality Assurance and Information Technology

Many endoscopists still complete their examination reports by dictation or freehand rather than using a computerized reporting system. This means that quality indicators are often not fully recorded and manual retrospective analysis is required for quality assurance.

The advantage of a computerized system is that software can be created that insists on quality indicators being entered. Further development of the software enables comparisons to be made between oxygen desaturation, the amount of sedation, and successful cecal intubation, for example. At present, the major drawback with quality assurance is the absence of commercially available software systems that are able to record and analyze the relevant data in the way indicated above. Some argue that the use of computerized endoscopic reporting seriously prolongs the time taken to complete the report. This is certainly true of a number of software systems that have been developed. However, the better-designed ones can be used with considerable speed once the endoscopist has completed the learning curve.

There is a need for better and more readily available systems using generally accepted terminology, such as the Minimal Standard Terminology published by the World Organization of Digestive Endoscopy/*Organisation Mondiale d'Endoscopie Digestive* (OMED) [11]. A further advantage of a computerized system is that it provides a typed (and therefore legible) report that is immediately available for despatch to referring clinicians or the patients themselves. A computer-generated report saves secretarial time and storage space and allows immediate access to previous endoscopy reports.

For individuals and departments without access to computerized reporting, quality assurance is limited to retrospective analysis of written or typed reports, or specific prospective audits undertaken as a separate exercise, which is often incomplete and subjective.

A simple example of the colonoscopy success rate obtained from eight colonoscopists working in a department in England over a 3-month period is shown in **Fig. 2.2**. Similar data can be extrapolated in graphic form showing the ASA grades of the patients examined, the number of polyps identified, and the average dose of sedation used [12].

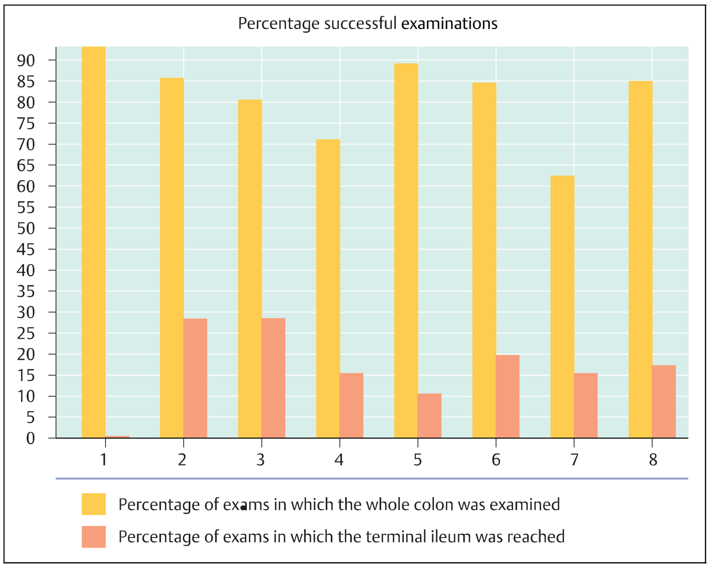


Fig. 2.2 Success for total colonoscopy (%).

How Should Quality Assurance Data Be Used?

Quality Standards

The aim of quality assurance is to ensure that patients receive a high standard of care within the endoscopy unit. For this to be possible, it is necessary to set certain quality standards. For example, a department, a health-care provider, or a national endoscopy society might recommend that endoscopists should be able to perform total colonoscopy 90 % of the time and that they should be able to retrieve at least one tubular adenoma from at least 15 % of the examinations that they undertake. By monitoring the endoscopists in a unit using the techniques outlined above, it would become apparent which endoscopists were not reaching the prescribed quality level. This would lead to an analysis of that endoscopist's data to see whether, for example, he or she was not spending sufficient time trying to reach the cecum, whether the patient mix was different or the patients were less well prepared, older, or less healthy, or whether insufficient sedation was being used. Remedial action could then be taken, which might involve the endoscopist concerned having a period of performing endoscopy under supervision.

Quality assurance should not be threatening. The data in **Fig. 2.2** are anonymized and were sent to all eight colonoscopists, each of whom knew his or her own number but was not able to identify the others. All of the numbers were known to the quality assurance supervisor, an experienced colonoscopist who was able to take individual action if it became necessary. The availability of these data, circulated by e-mail, enabled those who were less successful to identify where their examinations were falling short.

Trainees

Routine prospective collection of data is helpful in assessing the progress of trainees. The use of this technology allows more objective assessment of the trainees' success, which is a better method of determining competence than assessing it on the basis of the number of procedures performed or one or two endoscopies carried out under supervision.

Continuous Quality Improvement

Quality assurance should not be used to provide only a minimum quality of treatment. When applied correctly, it should engender continuous improvement in quality, and this can be done only by frequent monitoring of quality indicators, with regular assessment as to how the quality can be improved. This should be applied across the whole range of the service being provided and include waiting times, scheduling, cost management, efficiency in the endoscopy unit, and staff satisfaction, in addition to improving technical success rates and clinical outcomes. In the United Kingdom, this approach has been introduced into the National Health Service using the endoscopy Global Rating Scale (GRS).

The Endoscopy Global Rating Scale

Total control of medicine by the government ("socialized medicine") medicine enables government to introduce quality regulations and insist that they be followed. In the United Kingdom, the Department of Health has introduced a web-based questionnaire that all National Health Service endoscopy units are expected to complete [13]. It is divided into two separate dimensions: clinical quality and quality of patient experience. Each of these two dimensions includes 12 patient-centered items (**Table 2.7**). Each of the 24 items in turn has a series of statements to which the endoscopy director has to answer "yes" or "no" online. On the basis of these replies, the Department of Health is able to derive a global rating score, the lowest level being D and the highest A. Since its inception, the percentage of units scoring A or B has increased. To achieve a high rating means that there has to be continuous monitoring of a variety

Table 2.7 The twelve patient–centered standards used in the United Kingdom Global Rating Scale for endoscopy

Clinical quality	Quality of patient experience
• Appropriateness	• Equality
• Information/consent	• Timeliness
• Safety	• Choice
• Comfort	• Privacy and dignity
• Quality	• Aftercare
• Timely results	• Ability to provide feedback

Source: www.grs.nhs.uk.

2

of quality indicators, with an achievement of a colonoscopy completion rate of over 90 %, and an adenoma detection rate of over 10 %, with a polyp recovery rate of more than 90 %. Sedation and analgesia, comfort levels, good-quality bowel preparation, and continuous monitoring for complications have to be performed. Further details, together with a list of quality and safety indications for endoscopy, are available on the GRS web site (www.grs.nhs.uk).

Impact of Quality Assurance on Endoscopic Practice

The introduction of quality assurance undoubtedly increases the workload not just for the endoscopist, but for most of the team working in the endoscopy unit and in particular the chief nurse and endoscopy director. Continuous monitoring and regular auditing increases the cost of running the endoscopy unit, and in addition will identify defective equipment requiring replacement. Examinations take longer if the endoscopist adheres to recommended standards—for example, it takes longer to obtain informed consent, and the extubation time at endoscopy may have to be increased to maximize the number of polyps identified.

Quality assurance also covers efficiency in the endoscopy unit and should lead to more appropriate scheduling, a reduction in the numbers of unnecessary endoscopies performed, and more efficient methods of reducing turnaround time. Improved patient satisfaction should lead to fewer complaints and a reduction in litigation. The most important outcome should be an improvement in the clinical effectiveness of endoscopy [14,15], fewer complications, more satisfied patients, and improved conditions for staff, leading to a higher rate of staff retention, better morale, and pride in the service being provided.

I

What Are the Next Steps?

The principles underlying quality assurance in endoscopy are now firmly established. There is general agreement on which quality indicators should be recorded. To date, however, there is no universal consensus regarding the level of quality that should be achieved. National and international organizations are beginning to appreciate that it is necessary to set certain standards that will have to be reached if an individual endoscopist is to remain in practice or if a department is to continue to provide a service. We can expect to see the introduction of specific parameters within the next few years.

Standards will be set on the basis of what is considered to be good practice. Provided that individual endoscopists are competently trained and that they continue to perform a sufficient number of procedures on a regular basis and attend courses in professional development, there should be little difficulty in maintaining an acceptable endoscopic standard. No doctor enjoys practicing suboptimally. Among those who practice within accepted guidelines, the risk of litigation will fall. Refresher courses will be required for those who would benefit from them.

Managing the Endoscopy Unit

It is becoming recognized that specific skills and training are required for individuals who manage endoscopic services. OMED initiated a series of Endoscopy Directors' Workshops in 2005 in order to improve the standard of endoscopy worldwide. Many aspects of the workshops are concerned with quality in one way or another, but an important section is specifically designed to discuss quality assurance in the endoscopy unit. A group within the ASGE is also hoping to set up a section within the society to address issues relating to endoscopy unit management [16]. These workshops and meetings have identified important areas of management not previously addressed by health-care providers or by national societies. A major deficiency is the inadequate provision of information technology in endoscopy. Although some organizations have attempted to stimulate industry to take an interest in this area, the products created have not fulfilled requirements. Considerable work is needed in this area.

References

1. Suetonius. The twelve Caesars, trans. Robert Graves, rev. ed. James Rives. London: Penguin; 2007; p. 59.
2. Donabedian A. Evaluating the quality of medical care. Milbank Mem Fund Q 1966; 44: 166–206.
3. Brown RD, Goldstein JL. Quality assurance in the endoscopy unit: an emphasis on outcomes. Gastrointest Endosc Clin N Am 1999; 9: 595–607.
4. Bjorkman DJ. Measuring the quality of endoscopy. Gastrointest Endosc 2006; 63: S 1–2.
5. American Society for Gastrointestinal Endoscopy. Appropriate use of gastrointestinal endoscopy. Gastrointest Endosc 2000; 52: 831–7.
6. Vader JP, Burnand B, Froehlich F, Dubois RW, Bochud M, Gonvers JJ. The European Panel on Appropriateness of Gastrointestinal Endoscopy (EPAGE): project and methods. Endoscopy 1999; 31: 575–8.
7. Adler A, Roll S, Marowski B, Drossel R, Rehs HU, Willich SN, et al. Appropriateness of colonoscopy in the era of colorectal cancer screening: a prospective, multicenter study in a private-practice setting (Berlin Colonoscopy Projecct I, BECOP). Dis Colon Rectum 2007; 50: 1628–38.
8. Hassan C, Bersani G, Buri L, Zullo A, Anti M, Bianco MA, et al. Appropriateness of upper-GI endoscopy: an Italian survey on behalf of the Italian Society of Digestive Endoscopy. Gastrointest Endosc 2007; 65: 767–74.
9. Chan TH, Goh KL. Appropriateness of colonoscopy using the ASGE guidelines: experience in a large Asian hospital. Chin J Dig Dis 2006; 7: 24–32.
10. Shepherd H, Hewett D. Guidance for obtaining a valid consent for elective endoscopic procedures. A report of the Working Party of the British Society of Gastroenterology. London: British Society of Gastroenterology; 2008. Available from: http://www.bsg.org.uk/images/stories/docs/clinical/guidelines/endoscopy/consent08.pdf.
11. World Organization of Digestive Endoscopy. Minimal Standard Terminology MST 3.0. Munich, Germany: OMED Committee of Documentation and Standardization, 2008. Available from: http://www.omed.org/index.php/resources/re_mst/.
12. Naylor G, Gatta L, Butler A, Duffet S, Wilcox M, Axon AT, et al. Setting up a quality assurance program in endoscopy. Endoscopy 2003; 35: 701–7.
13. GRS Global Rating Scale [Internet]. Available from: www.grs.nhs.uk.
14. Ball JE, Osbourne J, Jowett S, Pellen M, Welfare MR. Quality improvement programme to achieve acceptable colonoscopy completion rates: prospective before and after study. BMJ 2004; 329: 665–7.
15. Imperiali G, Minoli G, Meucci GM, Spinzi G, Strocchi E, Terruzzi V, et al. Effectiveness of a continuous quality improvement program on colonoscopy practice. Endoscopy 2007; 39: 314–8.
16. Al-Kawas FH. Proposed endoscopy directors SIG. ASGE News 2008; 15: 26.