OPERATIVE ENDOSCOPIC & MINIMALLY INVASIVE SURGERY

Edited by
Daniel B. Jones
Steven D. Schwaitzberg

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Operative Endoscopic and Minimally Invasive Surgery

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Edited by
Daniel B. Jones, MD, MS
Professor of Surgery
Harvard Medical School
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Steven D. Schwaitzberg, MD, FACS
Professor and Chair of Surgery
Jacobs School of Medicine and Biomedical Sciences
The State University of New York
Buffalo, New York

Art Editor
Cara M. Jordan, PhD
Provost's Fellow in the Arts
Center for the Humanities
Graduate Center, City University of New York
New York City, New York

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Foreword

Logic will get you from A to B. Imagination will take you everywhere.

Albert Einstein

When Dan and Steve asked me to write the Foreword for this book, I looked at the book's outline and had three observations:

- It is an enormous honor to add a Foreword to this monumental work, *Operative Endoscopic and Minimally Invasive Surgery*, with its 120 chapters covering the mini-invasive and endoscopic procedures with contributions from 241 authors.
- The chapter authors represent the brightest stars in the firmament for every segment of minimally invasive operative procedures. I know almost every one and would trust them to make surgical decisions for me if needed. Many of them are close personal friends. Wrangling that many surgical superstars will be an interesting process.
- I hope the section on hernia repair is the best one, because carrying this book will improve business.

In my experience, this is the first textbook that seriously addresses COST (which conversion factors are used?), a factor that has become part of the surgical decision-making process. I congratulate the authors for this dive into reality. It is amazing for me, having participated in the (r)evolution of endoscopic surgery for more than 60 years, performing some of the procedures for decades, how much our thinking has evolved. One can only imagine the names of the chapters in the second edition of the text in 10 years.

When, after 3 years of hard work, I was able to publish a compendium of *Endoscopy* (Appleton Century Croft, New York) in 1976 with 60 chapters, and it was considered a "complete guide." It covered the basic principles of the physics, optics, electronics, video, communications, as well as every procedure known at that time. We had 52 authors whose writings were interpreted as "modern data" or regarded by many as a *utopian* view of surgery.

There is no utopia. We keep changing the definition for the better. We should be grateful that Daniel Jones and Steve Schwaitzberg's imagination and integrity are unlimited, and these 241 authors will set the bar even higher. Good!

George Berci, MD, FRCS, Ed (Hon)
Cedars-Sinai Medical Center
Los Angeles, California

Preface

Celioscopy, peritoneoscopy, or laparoscopy as it has been termed has been around in its earliest inceptions for at least 100 years. The era minimally invasive surgery exploded after the first videoscopic laparoscopic cholecystectomies were presented at Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and the American College of Surgeons (ACS). It became obvious pretty quickly that patients benefited of smaller scars, less pain, less intrusion, and faster recovery. Almost overnight, surgeons began to apply minimally invasive approaches to more and more operations. Today, laparoscopy is the standard approach for most diseases of the colon, hernia, spleen, and stomach. For more complex procedures, robotic-assisted surgery has made operations, such as the reconstruction after pancreatic head resection, more precise than perhaps even open surgery.

The flexible endoscope, once the domain of the surgeons, is returning home in part as advances in therapeutic endoscopy change the face of GI tract surgery. No longer can a GI surgeon afford not to be proficient with this tool. Surgeons are preforming Natural Orifice Endoscopic Surgery (NOTES), transanal procedures including Transanal Minimally invasive Surgery (TAMIS, TEMS), and are performing endoscopic mucosal/submucosal dissection and resection (ESD, EMR). The flexible endoscope is a tool of the modern general surgeon well beyond simple screening applications.

Operative Endoscopic and Minimally Invasive Surgery is the first major textbook to describe new and potentially better approaches to old operations by experts. The chapters are concise and emphasize technique. The color artwork rivals other leading atlases. One feature that makes this book particularly valuable is the expert commentary that critiques the authors' preoperative assessment, operative approach, and outcomes. The reader can quickly understand the operative pearls and potential challenges to a given operative procedure.

We think another appeal of this book is the beautiful classic and contemporary art. Medicine and Surgery evolved as surgeons learned anatomy. Historical paintings have captured the first used operative tools, ether anesthesia, and apprentice model of teaching in operative theaters. Many thanks to Cara Jordan, who curated this collection. In *Operative Endoscopic and Minimally Invasive Surgery*, we have sought to bring the replicas of the art of surgery over time to the reader. We hope to capture the imagination and creativity of all our readers.

Daniel B. Jones, MD, MS

Steven D. Schwaitzberg, MD, FACS

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Editors

Daniel B. Jones, MD, MS, is a professor of Surgery at Harvard Medical School, vice chair of Surgery at the Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA.

Steven D. Schwaitzberg, MD, FACS, is professor of Surgery SUNY Buffalo, chair of surgery SUNY Buffalo Medical Center, Buffalo, New York, USA.

Contributors

Adewale O. Adisa, FWACS, FCMS
Department of Surgery
Obafemi Awolowo University
Ile-Ife, Nigeria

Piyush Aggarwal, MD
Advanced Laparoscopy, Endoscopy and Ultrasound
St. Vincent Hospital
Indianapolis, Indiana

Matthew R. Albert, MD, FASCRS
Center for Colon and Rectal Surgery
Florida Hospital
Orlando, Florida

Hana Alhomoud, MD
Department of Surgery
Al Sabah Hospital
Kuwait City, Kuwait

Aman Ali, MD
Department of Medicine
Wilkes Barre General Hospital
The Commonwealth University Medical College
Edwardsville, Pennsylvania

Brandon D. Andrew, MD
Medical and Surgical Weight Loss Clinic
HSHS Sacred Heart and Evergreen Surgical
Eau Claire, Wisconsin

Alexandra Argiroff, MD
Mount Sinai Medical Center
New York City, New York

Maurice E. Arregui, MD
Advanced Laparoscopy, Endoscopy
and Ultrasound
St. Vincent Hospital
Indianapolis, Indiana

Horacio J. Asbun, MD
Hepatobiliary and Pancreas Surgery
Miami Cancer Institute
Miami, Florida

and

Mayo College of Medicine and Sciences
Uttar Pradesh, India

Dan Azagury, MD
Section of Bariatric and Minimally Invasive Surgery
Stanford University School of Medicine
Stanford, California

Michele L. Babicky, MD
Hepatobiliary and Surgical Oncology
Gastrointestinal and Minimally Invasive Surgery
The Oregon Clinic
Portland, Oregon

Sharon L. Bachman, MD
Department of Surgery
Inova Medical Group
Falls Church, Virginia

Eric Balent, MD
Department of Surgery
Tripler Army Medical Center
Honolulu, Hawaii

Sheila Ryan Barnett, MD
Department of Anesthesia, Critical Care and Pain Medicine
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Tim Batchelor, BSc, MBChB, MSc, FRCS(CTh)
Department of Thoracic Surgery
Bristol Royal Infirmary
Bristol, United Kingdom

David E. Beck, MD, FASCRS
Department of Colon and Rectal Surgery
Ochsner Clinic Foundation
New Orleans, Louisiana

John-Paul Bellistri, MD
Columbia University Medical Center
New York Presbyterian Lawrence Hospital
Bronxville, New York

Abel Bello, MD, FASMBS
MIB Surgery
Plantation, Florida

Tyler Berzin, MD, MS, FASGE
GI Endoscopy
Advanced Therapeutic Endoscopy Fellowship
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Marc G.H. Besselink, MD, MSC, PhD
Department of Surgery
Academic Medical Center
Amsterdam, the Netherlands

Elif Bilgic, PhD
Steinberg Centre for Simulation and Interactive Learning
McGill University
and
Steinberg-Bernstein Centre for Minimally Invasive Surgery and Innovation
McGill University Health Centre
Montreal, Canada

Sarah E. Billmeier, MD, MPH
Section of General Surgery
Division of Minimally Invasive Surgery
Dartmouth-Hitchcock Medical Center
Lebanon, New Hampshire

Cherif Boutros, MD, MSC
Department of Surgery
Division of General and Oncologic Surgery
University of Maryland School of Medicine
Baltimore, Maryland

Wolfram Breithaupt, MD
AGAPLESION Markus Krankenhaus
Department of Surgery
Frankfurt, Germany

Rita A. Brintzenhoff, MD
Department of General Surgery
Carolinas Medical Center
Charlotte, North Carolina

Fred Brody, MD, MBA
Department of Surgery
The George Washington University Medical Center
Washington, DC

Alessandro Brunelli, MD
Department of Thoracic Surgery
St. James's University Hospital
Leeds, United Kingdom

L. Michael Brunt, MD
Section of Minimally Invasive Surgery
Washington University School of Medicine
and
St. Louis Blues Hockey Club
St. Louis, Missouri

Brian T. Bucher, MD
Department of Surgery
Primary Children's Hospital
University of Utah School of Medicine
Salt Lake City, Utah

John P. Burke, PhD, FRCSI
Center for Colon and Rectal Surgery
Florida Hospital
Orlando, Florida

Ali Linsk Butash, MD
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Jeffrey A. Cadeddu, MD
Department of Urology
University of Texas Southwestern Medical Center
Dallas, Texas

Mark P. Callery, MD
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Avery C. Capone, MD
Harvard Plastic Surgery
Brigham and Women's Hospital
Boston, Massachusetts

Christy E. Cauley, MD, MPH
Cleveland Clinic
Cleveland, Ohio

I. Bulent Cetindag, MD
Department of Surgery
Mercy Medical Center
University of Iowa
Cedar Rapids, Iowa

Austin L. Chiang, MD, MPH
Division of Gastroenterology, Hepatology, and Endoscopy
Brigham and Women's Hospital
Boston, Massachusetts

Songita Choudhury, BS
College of Medicine
Center for Advanced Surgical Technology
University of Nebraska Medical Center
Omaha, Nebraska

Ian Choy
Division of General Surgery
Oakville Trafalgar Memorial Hospital Halton Healthcare
McMaster University
Oakville, Canada

Margaret E. Clark, MD
Department of Surgery
Tripler Army Medical Center
Honolulu, Hawaii

Paul Colavita, MD
Division GI and Minimally Invasive Surgery
Carolinas Medical Center
Charlotte, North Carolina

Jonathan F. Critchlow, MD
Division of General Surgery
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Lisa A. Cunningham, MD
The Ohio State University Wexner Medical Center
Columbus, Ohio

Suvranu De, ScD
Center for Modeling, Simulation and Imaging in Medicine
Rensselaer Polytechnic Institute
Troy, New York

Ronald P. DeMatteo, MD
Department of Surgery
Perelman School of Medicine
University of Pennsylvania
Philadelphia, Pennsylvania

Michele Diana, MD
IRCAD, Research Institute Against Cancer of the Digestive System
and
IHU-Strasbourg, Institute for Image-Guided Surgery
Strasbourg, France

Ernesto Dominguez, MD
Baptist Health South Florida
Miami, Florida

Ostap Dovirak, MD
Department of Surgery
Division of Urology
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Quan-Yang Duh, MD
Endocrine Surgery and Oncology
Department of Surgery
Mount Zion Hospital
University of California—San Francisco
San Francisco, California

Brian J. Dunkin, MD
Methodist Institute for Technology, Innovation, and Education (MITIE)
Houston Methodist Hospital
Houston, Texas

Brandice Durkan, MD
General and Breast Surgery
Tuality Digestive Health and General Surgery Clinic
Hillsboro, Oregon

Konstantinos P. Economopoulos, MD, PhD
General Surgery Resident
Department of Surgery
Duke University Medical Center
Durham, North Carolina

and

Surgery Working Group
Society of Junior Doctors
Athens, Greece

James Ellsmere, MD, MS, FRCSC
Department of General Surgery
Dalhousie University
Halifax, Canada

Nassrene Y. Elmadhun, MD
Minimally Invasive Thoracic Surgery
Division of Thoracic Surgery and Interventional Pulmonology
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Ilaria Ernesti, MD
Department of Experimental Medicine-Medical Physiopathology
Food Science and Endocrinology Section
"Sapienza" University of Rome
Rome, Italy

Tsuyoshi Etoh, MD, PhD
Department of Gastroenterological and Pediatric Surgery
Oita University Faculty of Medicine
Oita, Japan

Robert D. Fanelli, MD, MHA, FASGE
Geisinger Commonwealth School of Medicine
Minimally Invasive Surgery
Surgical Endoscopy
Department of Surgery
The Guthrie Clinic
Sayre, Pennsylvania

Liane S. Feldman, MD, CM
Steinberg-Bernstein Chair in Minimally Invasive Surgery and Innovation
McGill University Health Centre
Montreal, Canada

Edward L. Felix, MD
Marian Regional Medical Center
Santa Maria, California

Gustavo Fernandez-Ranvier, MD, PhD
Department of Surgery
Division of Metabolic, Endocrine and Minimally Invasive Surgery
Mount Sinai Medical Center
New York City, New York

Lorenzo E. Ferri, MD, PhD
Division of Thoracic Surgery
McGill University
Montreal, Canada

James Fleshman, MD, FASCRS
Department of Surgery
Baylor University Medical Center
Dallas, Texas

Yuman Fong, MD
Sangiacomo Chair in Surgical Oncology
Department of Surgery
International Medicine
City of Hope Comprehensive Cancer Center
Duarte, California

Morris E. Franklin Jr., MD
Department of Minimally Invasive Surgery Texas Endosurgery Institute
San Antonio, Texas

Gerald M. Fried, MSC, MD, FRCSC, FCAHS
Department of Surgery
McGill University
Montreal, Canada

Hans F. Fuchs, MD
Department of General, Visceral and Cancer Surgery
University of Cologne
Cologne, Germany

Karl-Hermann Fuchs, MD
University of California San Diego
Center for the Future of Surgery
La Jolla, California

Pascal R. Fuchshuber, MD, PhD
General and Oncologic Surgery
UCSF-East Bay
The Permanente Medical Group, Inc.
Walnut Creek, California

Hajime Fujishima, MD
Department of Gastroenterological and Pediatric Surgery
Oita University Faculty of Medicine
Oita, Japan

David Fuks, MD, PhD
Department of Digestive, Oncological and Metabolic Surgery
Institut Mutualiste Montsouris
Paris, France

Eleanor C. Fung, MD
Department of Surgery
Jacobs School of Medicine and Biomedical Sciences
University at Buffalo
The State University of New York
Buffalo, New York

Scott Furer, MD
Department of Pediatrics
Johns Hopkins All Children's Hospital
St. Petersburg, Florida

Michel Gagner, MD
Clinique Michel Gagner
Montreal, Canada

Alberto S. Gallo, MD
Baptist Surgical Associates
Baptist Health Hospital
Louisville, Kentucky

Sidhu Gangadharan, MD
Department of Thoracic Surgery
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Brice Gayet, MD, PhD
Department of Digestive, Oncological and Metabolic Surgery
Institut Mutualiste Montsouris
Paris, France

Andres Gelrud, MD, MMSc
Pancreatic Disease Center
Gastro Health and Miami Cancer Institute
Baptist Hospital South Florida
Miami, Florida

Alfredo Genco
Department of Surgical Sciences
Policlinico Umberto I
"Sapienza" University of Rome
Rome, Italy

Robert Gianotti, MD
Albany Gastroenterology Consultants
Albany, New York

Fahri Gokcal, MD
Department of General Surgery
University of Health Sciences Istanbul Bakirkoy Dr. Sadi Konuk Training and Research Hospital
Istanbul, Turkey

and

Good Samaritan Medical Center
Brockton, Massachusetts

Anthony Gonzalez, MD, FASMBS
Baptist Hospital of Miami
FIU College of Medicine
Bariatric Surgery
Baptist Health South Florida
Miami, Florida

Carroll M. Harmon, MD, PhD
Department of Surgery
Jacobs School of Medicine and Biomedical Sciences
University at Buffalo
Buffalo, New York

Cristina R. Harnsberger, MD
Department of Surgery
University of California, San Diego
San Diego, California

Jeffrey N. Harr, MD, MPH
Department of Surgery
The George Washington University Medical Center
Washington, DC

Yasushi Hasegawa, MD, PhD
Department of Surgery
Iwate Medical University School of Medicine
Iwate, Japan

Jeffrey W. Hazey, MD
Memorial Hospital
Marysville, Ohio

Sara A. Hennessy, MD
Department of Surgery
UT Southwestern Medical Center
Dallas, Texas

Juan D. Hernandez, MD
Hospital Universitario Fundacion Santa Fe de Bogota
Universidad de los Andes Faculty of Medicine
Bogota, Colombia

Miguel A. Hernandez, MD
Department of Minimally Invasive Surgery
Texas Endosurgery Institute
San Antonio, Texas

Daniel M. Herron, MD
Department of Surgery
Icahn School of Medicine at Mount Sinai
New York City, New York

Steven N. Hochwald, MD
Department of Surgical Oncology
Roswell Park Cancer Institute
Buffalo, New York

Santiago Horgan, MD
Department of Surgery
Center for the Future of Surgery
University of California, San Diego

Douglas Horst, MD
Department of Medicine
Division of Gastroenterology
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Karen D. Horvath, MD
Department of Surgery
University of Washington
Seattle, Washington

Eric S. Hungness, MD
Department of Surgery
Northwestern University
Chicago, Illinois

Matthew M. Hutter, MD, MPH
Department of Surgery
Harvard Medical School
Massachusetts General Hospital
Boston, Massachusetts

David A. Iannitti, MD
Department of Surgery Carolinas Medical Center
Division of Hepato-Pancreatico-Biliary Surgery
Charlotte, North Carolina

William B. Inabnet III, MD
Department of Surgery
Icahn School of Medicine at Mount Sinai
New York City, New York

Gretchen P. Jackson, MD, PhD
Department of Pediatric Surgery
Vanderbilt University School of Medicine
Nashville, Tennessee

Brian Jacob, MD
Mount Sinai Medical Center
New York City, New York

Garth R. Jacobsen, MD
Department of Surgery
University of California, San Diego
San Diego, California

Daniel B. Jones, MD, MS
Harvard Medical School
and
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Edward L. Jones, MD, MS
Department of Surgery
Rocky Mountain Regional VA Medical Center
The University of Colorado Anschutz Medical Campus
Aurora, Colorado

Stephanie B. Jones, MD
Department of Anesthesia, Critical Care and Pain Medicine
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Cara M. Jordan, PhD
Center for the Humanities
Graduate Center, City University of New York
New York City, New York

Namir Katkhouda, MD
Department of Surgery
University of Southern California
Los Angeles, California

Justin J. Kelly, MD, FRCSI
Center for Colon and Rectal Surgery
Florida Hospital
Orlando, Florida

Michael Kent, MD
Minimally Invasive Thoracic Surgery
Division of Thoracic Surgery and Interventional Pulmonology
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Tara S. Kent, MD
Department of Surgery
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Leena Khaitan, MD, MPH
Esophageal and Swallowing Center
University Hospitals
Digestive Health Institute
Cleveland Medical Center
Cleveland, Ohio

Sebastian K. King, MBBS, PhD, FRACS
Department of Paediatric Surgery
The Royal Children's Hospital
Melbourne, Australia

Boris Kiriazov, MD
Division of General Surgery
University of South Florida
Tampa, Florida

Russell C. Kirks, Jr., MD
Department of Surgery
Division of Hepato-Pancreatico-Biliary Surgery
Carolinas Medical Center
Charlotte, North Carolina

Seigo Kitano, MD, PhD
Oita University
Oita, Japan

Crystal Krause, PhD
Department of Surgery
Center for Advanced Surgical Technology
University of Nebraska Medical Center
Omaha, Nebraska

Cindy M. Ku, MD
Department of Anesthesia, Critical Care and Pain Medicine
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Omar Yusef Kudsi, MD, MBA
Robotic Surgery Fellowship
Good Samaritan Medical Center
Tufts University School of Medicine
Boston, Massachusetts

Moshim Kukar, MD
Department of Surgical Oncology
Roswell Park Cancer Institute
Buffalo, New York

Jacob C. Langer, MD
Division of General and Thoracic Surgery
Hospital for Sick Children
and
Department of Surgery
University of Toronto
Toronto, Canada

Aaron Lay, MD
Department of Urology
Emory University
Atlanta, Georgia

Jihui Li, MD
Horizon Health Paris Clinic
Paris, Illinois

Robert B. Lim, MD
Department of Surgery
Tripler Army Medical Center
Uniformed Services University of Health Sciences
Honolulu, Hawaii

Henry Lin, MD
Department of General Surgery
Naval Hospital Camp Lejeune
Uniformed Services University
Camp Lejeune, North Carolina

Emanuele Lo Menzo, MD, PhD, FASMBS
Cleveland Clinic Florida
Weston, Florida

Eric Luedke, MD
Section of Bariatric and Minimally Invasive Surgery
Stanford University School of Medicine
Stanford, California

Bill Ran Luo, MD
Department of Surgery
Northwestern Medicine
Chicago, Illinois

Marcel Autran Cesar Machado, MD
Sírio Libanês Hospital
University of São Paulo
São Paulo, Brazil

Amin Madani, MD, PhD, FRCSC
Department of Surgery
McGill University
and
Steinberg-Bernstein Centre for Minimally Invasive Surgery and Innovation
McGill University Health Centre
Montreal, Canada

Feroze Mahmood, MD
Department of Anesthesia
Critical Care and Pain Medicine
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Peter W. Marcello, MD, FASCRS
Division of Colon and Rectal Surgery
Lahey Hospital and Medical Center
Burlington, Massachusetts

Jacques Marescaux, MD, FRCS (Hon), FJSES (Hon), APSA (Hon)
IRCAD, Research Institute Against Cancer of the Digestive System
and
IHU-Strasbourg, Institute for Image-Guided Surgery
Strasbourg, France

Jeffrey M. Marks, MD, FASGE
Department of Surgery
Case Western/University Hospitals
Cleveland Medical Center
Cleveland, Ohio

John H. Marks, MD, FASCRS
Division of Colorectal Surgery
Lankenau Hospital
Wynnewood, Pennsylvania

Janet Martin, PharmD, MSc (HTA&M)
Centre for Medical Evidence, Decision Integrity and Clinical Impact
and
Department of Anesthesia and Perioperative Medicine
and
Department of Epidemiology and Biostatistics
Schulich School of Medicine and Dentistry
Western University
London, Canada

John B. Martinie, MD
HPB Surgery
Carolinas Medical Center
Charlotte, North Carolina

Brent D. Matthews, MD
Department of Surgery
Carolinas HealthCare System
University of North Carolina
Charlotte, North Carolina

Zachary McCabe, MD STUDENT
St. George University School of Medicine
Grenada, West Indies

Ozanan Meireles, MD
Massachusetts General Hospital
Boston, Massachusetts

John D. Mellinger, MD
Department of Surgery
Southern Illinois University School of Medicine
Springfield, Illinois

W. Scott Melvin, MD
Montefiore Medical Center
The University Hospital for Albert Einstein College of Medicine
New York City, New York

Dean J. Mikami, MD
Department of Surgery
John A. Burn School of Medicine
University of Hawaii
Honolulu, Hawaii

Mario Montealegre-Gallegos, MD
Department of Anesthesia
Critical Care and Pain Medicine
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Isacco Montroni, MD, PhD
Department of Colorectal Surgery
Cleveland Clinic Florida
Weston, Florida

John Morton, MD, MPH
Section of Bariatric and Minimally Invasive Surgery
Stanford University School of Medicine
Stanford, California

A. James Moser, MD
Pancreas and Liver Institute
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Carmen L. Mueller, MD, MEd
Division of General Surgery
McGill University
Montreal, Canada

Kenric M. Murayama, MD
Department of Surgery
John A. Burns School of Medicine
University of Hawaii
Honolulu, Hawaii

Konstantinos S. Mylonas, MD
School of Medicine
Faculty of Health Sciences
Aristotle University of Thessaloniki
Thessaloniki, Greece

and

Surgery Working Group
Society of Junior Doctors
Athens, Greece

Alex P. Nagle, MD
Department of Surgery
Feinberg School of Medicine
Northwestern University
Evanston, Illinois

Deborah M. Nagle, MD
Integrated Lead for Digital Surgery
Preclinical, Clinical and Medical
Medical Lead for the Colorectal Specialty
Ethicon, Inc.
Cincinnati, Ohio

Kai Neki, MD
University of California San Diego
Center for the Future of Surgery
La Jolla, California

Brian M. Nguyen, MD
Southern California Permanente Medical Group
Department of Surgery
Kaiser Permanente
San Diego, California

Stéphane Nicolau, PhD
IRCAD, Research Institute Against Cancer of the Digestive System
Strasbourg, France

Allan Okrainec, MD, MHPE
Temerty-Chang Telesimulation Centre
Division of General Surgery
University Health Network
University of Toronto
Toronto, Canada

Jaisa Olasky, MD
Mount Auburn Hospital
Cambridge, Massachusetts

and

Harvard Medical School
Boston, Massachusetts

Dmitry Oleynikov, MD
Department of Surgery
Center for Advanced Surgical Technology
University of Nebraska Medical Center
Omaha, Nebraska

John A. Olson, Jr., MD, PhD
Department of Surgery
Division of General and Oncologic Surgery
University of Maryland School of Medicine
Baltimore, Maryland

Lerna Ozcan, MD
Saint Elizabeth Medical Center
Boston, Massachusetts

Ping Pan, MD
Department of Surgery
University Hospitals Cleveland Medical Center
Cleveland, Ohio

Adrian E. Park, MD
Department of Surgery
Anne Arundel Medical Center
Annapolis, Maryland

Caroline Park, MD, MPH
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Sungsoo Park, MD, PhD
Department of Surgery
Korea University College of Medicine
and
Center for Obesity and Metabolic Diseases
Korea University Anam Hospital
Seoul, South Korea

Jesse D. Pasternak, MD, MPH
Endocrine Surgery and Oncology
Division of General Surgery
Toronto General Hospital – University Health Network
University of Toronto
Toronto, Canada

Neesha Patel, MD
Department of Pediatrics
Michigan Medicine
Ann Arbor, Michigan

Nicolò Pecorelli, MD
Steinberg-Bernstein Centre for Minimally Invasive Surgery
and Innovation
McGill University Health Centre
Montreal, Canada

Claire E. Peeples, MD
Department of Colon and Rectal Surgery
Beaumont Health
Royal Oak, Michigan

Kyle A. Perry, MD
Division of General and Gastrointestinal Surgery
Center for Minimally Invasive Surgery
The Ohio State University Wexner Medical Center
Columbus, Ohio

H. Charles Peters, MD
VCU Health
Richmond, Virginia

Vivian Pham, MD
Department of Anesthesia
University of California, San Francisco
San Francisco, California

Edward H. Phillips, MD
Department of Surgery
Division of General Surgery
Cedars Sinai Medical Center
Los Angeles, California

Matthew R. Pittman, MD
Metabolic Health and Surgical Weight Loss Center
Northwestern Medicine
Delnor Hospital
Geneva, Illinois

Douglas Pleskow, MD
Division of Gastroenterology
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Jaime Ponce, MD, FASMBS
Bariatric Surgery Program
CHI Memorial Hospital
Chattanooga, Tennessee

Jeffrey L. Ponsky, MD
Department of Surgery
Cleveland Clinic Lerner College of Medicine
Lynda and Marlin Younker Chair in Developmental Endoscopy
Case Western Reserve University
Cleveland, Ohio

Kinga A. Powers, MD, PhD, FRCSC
Department of Surgery
Salem Veteran Affairs Medical Center
University of Virginia School of Medicine
and
Virginia Tech Carilion School of Medicine
Salem, Virginia

Raymond R. Price, MD
Department of Surgery
Center for Global Surgery
University of Utah
and
Department of Surgery
Intermountain Medical Center
Intermountain Healthcare
Salt Lake City, Utah

Rebeca Dominguez Profeta, MD
University of California San Diego
Center for the Future of Surgery
La Jolla, California

Aurora D. Pryor, MD
Department of Surgery
Division of Bariatric, Foregut, and Advanced Gastrointestinal Surgery
Health Sciences Center
Stony Brook Medicine
Stony Brook, New York

Ruchir Puri, MD, MS
Department of General Surgery
University of Florida
Jacksonville, Florida

Bruce J. Ramshaw, MD
Department of Surgery
University of Tennessee Medical Center
Knoxville, Tennessee

Patrick Reardon, MD
Department of Surgery
Houston Methodist Hospital
Underwood Center for Digestive Disorders
Houston, Texas

Adam Reid, MD
Department of Surgery
Southern Illinois University School of Medicine
Springfield, Illinois

William S. Richardson, MD
General Surgery
Ochsner Clinic
Chalmette, Louisiana

Kurt Eric Roberts, MD
Gastrointestinal Surgery
Yale School of Medicine
New Haven, Connecticut

Santiago Rodriguez, MD
University of Colorado School of Medicine
Aurora, Colorado

Armando Rosales, MD
Cleveland Clinic Florida
Weston, Florida

Alexander Rosemurgy, MD
Florida Hospital
Tampa, Florida

Raul J. Rosenthal, MD
Department of General Surgery and the Bariatric and Metabolic Institute
Cleveland Clinic Florida
Weston, Florida

Sharona Ross, MD
Florida Hospital
Tampa, Florida

James C. Rosser, Jr., MD
University of Central Florida School of Medicine
Orlando, Florida

and

University at Buffalo School of Medicine
Buffalo, New York

Steven Rothenberg, MD
Columbia University College of Physicians and Surgeons
New York City, New York

and

The Rocky Mountain Hospital For Children
Denver, Colorado

David H. Rothstein, MD, MS
Department of Pediatric Surgery
John R. Oishei Children's Hospital
Buffalo, New York

Michael A. Russo, MD
Orange Coast Medical Center
Fountain Valley, California

Marvin Ryou, MD
Division of Gastroenterology, Hepatology, and Endoscopy
Brigham and Women's Hospital
Boston, Massachusetts

Benjamin Sadowitz, MD
Crouse Health
Syracuse, New York

Jean F. Salem, MD
Division of Colorectal Surgery
Lankenau Hospital
Wynnewood, Pennsylvania

Barry Salky, MD
Department of Surgery
Division of Metabolic, Endocrine and Minimally Invasive Surgery
Mount Sinai Medical Center
New York City, New York

Kulmeet Sandhu, MD
Department of Surgery
University of Southern California
Los Angeles, California

Bruce D. Schirmer, MD
Department of Surgery
University of Virginia
Charlottesville, Virginia

Christopher M. Schlachta, BSc, MDCM, FRCSC
Canadian Surgical Technologies and Advanced Robotics (CSTAR)
London Health Sciences Centre
London, Canada

Bradley F. Schwack, MD
NYU Langone Medical Center
NYU Langone Weight Management Program
New York City, New York

Daniel J. Scott, MD
Department of Surgery
UT Southwestern Medical Center
Dallas, Texas

Ketan Sheth, MD
Cambridge Health Alliance
Harvard Medical School
Boston, Massachusetts

Scott Shikora, MD
Center for Metabolic Health and Bariatric Surgery
and
Department of Surgery
Brigham and Women's Hospital
Harvard Medical School
Boston, Massachusetts

Daniel Shouhed, MD
Department of Surgery
Division of Bariatric and Minimally Invasive Surgery
Cedars Sinai Medical Center
Los Angeles, California

Jason K. Sicklick, MD
Department of Surgery
Division of Surgical Oncology
Moores Cancer Center
University of California, San Diego
La Jolla, California

Ajaypal Singh, MD
Division of Digestive Diseases and Nutrition
Rush Medical College
Chicago, Illinois

C. Daniel Smith, MD
Buckhead Surgical Associates
Atlanta, Georgia

Luc Soler, PhD
IRCAD, Research Institute Against Cancer of the Digestive System
Strasbourg, France

Nathaniel J. Soper, MD
Department of Surgery
Northwestern University
Chicago, Illinois

David Spector, MD
Center for Metabolic Health and Bariatric Surgery
and
Department of Surgery
Brigham and Women's Hospital
Harvard Medical School
Boston, Massachusetts

John A. Stauffer, MD
Department of General Surgery
Mayo Clinic Florida
Jacksonville, Florida

Dimitrios Stefanidis, MD, PhD, FASMBS, FSSH
MIS/Bariatric Surgery
Department of Surgery
Indiana University School of Medicine
Indianapolis, Indiana

Joel M. Sternbach, MD, MBA
Department of Surgery
Northwestern University
Chicago, Illinois

Alessandra Storino, MD
General Surgery Resident
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Hyunsuk Suh, MD
Department of Surgery
Icahn School of Medicine at Mount Sinai
New York City, New York

Lee L. Swanstrom, MD
Division of Minimally Invasive and GI Surgery
The Oregon Clinic
Portland, Oregon

and

Institute for Image Guided Surgery
IHU-Strasbourg
Strasbourg, France

Patricia Sylla, MD
Department of Surgery
Division of Colon and Rectal Surgery
Icahn School of Medicine at Mount Sinai Hospital
New York City, New York

Samuel Szomstein, MD, FASMBS
Cleveland Clinic Florida
Weston, Florida

Ezra N. Teitelbaum, MD
Department of Surgery
Northwestern University
Chicago, Illinois

Pieter Timmerman, MD
Department of Surgery
Academic Medical Center
Amsterdam, the Netherlands

Thadeus L. Trus, MD
Section of General Surgery
Division of Minimally Invasive Surgery
Dartmouth-Hitchcock Medical Center
Lebanon, New Hampshire

Shawn T. Tsuda, MD
Department of Surgery
University of Nevada School of Medicine
Las Vegas, Nevada

Thomas J. VanderMeer, MD
Geisinger Commonwealth School of Medicine
Department of Surgery
The Guthrie Clinic
Sayre, Pennsylvania

Gabor Varga, MD
AGAPLESION Markus Krankenhaus
Department of Surgery
Frankfurt, Germany

Melina C. Vassiliou, MD, MEd
Steinberg-Bernstein Centre for Minimally Invasive Surgery and Innovation
McGill University Health Centre
Montreal, Canada

Vic Velanovich, MD
Division of General Surgery
University of South Florida
Tampa, Florida

Vaibhav Wadhwa, MD
Gastroenterology and Hepatology
Cleveland Clinic Florida
Weston, Florida

Andrew A. Wagner, MD
Department of Surgery
Division of Urology
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Go Wakabayashi, MD, PhD
Department of Surgery
Ageo Central General Hospital
Ageo, Japan

Judy Wang, MD
General Surgery
Los Angeles County Harbor
UCLA Medical Center Surgery
Torrance, California

Susanne Warner, MD
City of Hope Department of Surgery
Duarte, California

Yusuke Watanabe, MD
Department of Gastroenterological Surgery II
Hokkaido University Graduate School of Medicine
Sapporo, Hokkaido, Japan

and

Steinberg-Bernstein Centre for Minimally Invasive Surgery and Innovation
McGill University Health Centre
Montreal, Canada

Ammara A. Watkins, MD, MPH
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, Massachusetts

Jaclyn Weirzbicki, MD
Department of Surgery
Northwestern Medicine Delnor Hospital
Geneva, Illinois

Steven D. Wexner, MD, PhD (Hon), FRCS, FRCS (Ed), FRCSI (Hon)
Department of Colorectal Surgery
Cleveland Clinic Florida
Weston, Florida

and

College of Medicine
Florida Atlantic University
Boca Raton, Florida

and

College of Medicine
Florida International University
Miami, Florida

Kelley Whitmer, MD
Department of Radiology
Virginia Tech Carilion School of Medicine
and
Department of Imaging Services
Carilion Clinic
Roanoke, Virginia

Gary Wind, MD
Uniformed Services University
Walter Reed National Military Medical Center
Washington, DC

Elan R. Witkowski, MD, MS
Department of Surgery
Harvard Medical School
Massachusetts General Hospital
Boston, Massachusetts

Jared Wong, MD
Sharp Rees-Stealy
San Diego, California

Stephanie G. Wood, MB, BCh
GI and General Surgery
Oregon Health and Science University
Portland, Oregon

James Wooldridge, MD
General Surgery
Ochsner Clinic
New Orleans, Louisiana

D. Tami Yamashita, MD
Department of General Surgery
Dalhousie University
Halifax, Canada

and

Department of General Surgery
Abbotsford Regional Hospital and Cancer Centre
Abbotsford, Canada

Tonia M. Young-Fadok, MD, MS, FASCRS
Division of Colon and Rectal Surgery
Mayo Clinic College of Medicine
Mayo Clinic
Phoenix, Arizona

Yuliya Yurko, MD
Division of Colon and Rectal Surgery
Mayo Clinic
Phoenix, Arizona

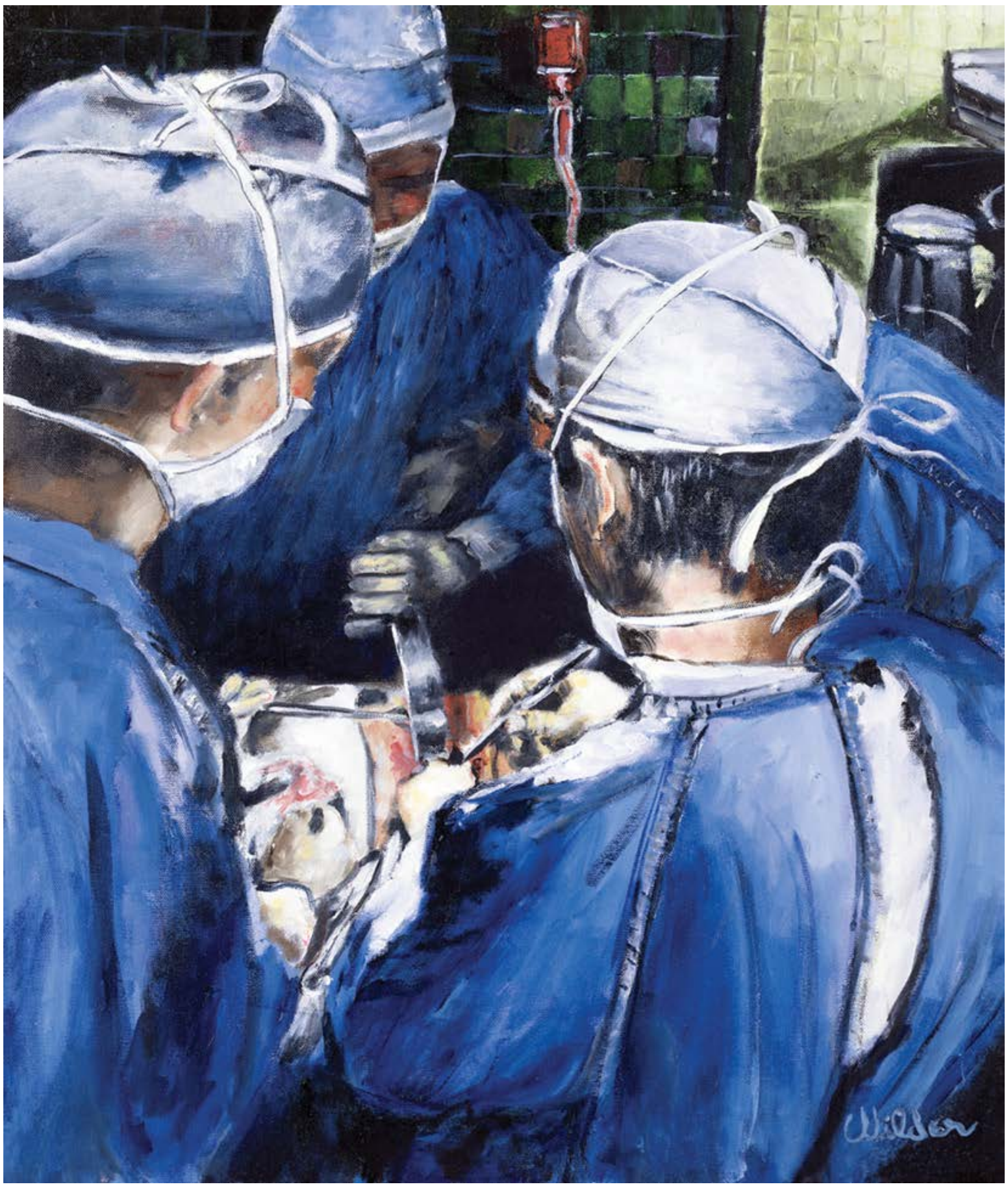
H. Reza Zahiri, DO
Division of Gastrointestinal and Bariatric Surgery
Anne Arundel Medical Center
Annapolis, Maryland

Yulia Zak, MD
Massachusetts General Hospital
Boston, Massachusetts

Natan Zundel, MD, FASMBS
Florida International University College of Medicine
Miami, Florida

SECTION I

Minimally invasive surgery in the modern health care environment



Joe Wilder, *Operating Team*, 1987. Giclée print, 24 × 20 inches. (Photo courtesy the Joe Wilder Collection.)

There are few images that visualize the inner workings of the operating room with its technological advances and yet profoundly intimate and explicit views into the human body. Retired surgeon Dr. Joe Wilder provides a unique glimpse into the process through his paintings, which depict surgeries from the point of view of one of the actors. Peering over the shoulders of the surgeons in this image, we become a part of the operating team. We are given a momentary slice of what that responsibility might look like, even if we cannot experience it ourselves.

While still a practicing surgeon—the chief of surgery at New York's Hospital for Joint Diseases and a professor of surgery at Mount Sinai Medical School—Dr. Wilder reorganized his schedule to have time every day to devote to art. He became an acclaimed painter alongside his surgical practice, earning accolades from the *New York Times* and prominent critics for his exhibitions and books. In his words, "In my paintings I encapsulated a half a century as a committed doctor, highlighting the powerful forces and actions which take place daily in a major hospital setting."

Dr. Wilder's motivation comes from his belief that surgeons have a responsibility to those who seek their help. He tries to reflect his commitment to patient care in each of his paintings. He says, "Although hospitals have a macabre quality, they remain beacons of hope for the afflicted and suffering. But I see another side, and this is what my paintings depict. I have envisioned such richness and giving where paragons of kindness and love heal. A hospital after all has no equal as a center to alleviate suffering. The countless patients from all walks of life taught me about the beauty of the human spirit."

Quotes from "Statement by Joe Wilder," Joe Wilder Medical Art, published 2011, https://joewilder.webs.com/statementby-joewilder.htm.

1

Cost implications in minimally invasive surgery

CHRISTOPHER M. SCHLACHTA AND JANET MARTIN

INTRODUCTION

It is generally accepted that the technology required to perform advanced laparoscopy is more costly than the standard instruments employed for open surgery. However, these added operating room costs are rationalized on the presumption that we will realize downstream mitigation through faster recovery. Even though total hospital costs may remain elevated, we justify this on the basis of an acceptable level of increased costs required to achieve the improved outcomes provided by laparoscopy. We may be willing to pay more for better outcomes, but there is a limit to the amount of extra resources we are willing to commit, especially for relatively small benefits. In this chapter we explore the cost-effectiveness and provide some practical insight into the cost implications of introducing expensive new equipment into the value equation for minimally invasive surgery.

BACKGROUND AND RATIONALE FOR ECONOMIC ANALYSIS FOR MINIMALLY INVASIVE SURGERY

Physicians and surgeons have a moral and ethical responsibility to provide their patients with the best possible care. If one is not concerned with resources, then the choice of which of two possible therapies to offer a patient becomes an exercise in assessing the evidence of effectiveness. For example, if **Therapy A** is more effective than **Therapy B**, then we prescribe **Therapy A** (**Figure 1.1**).

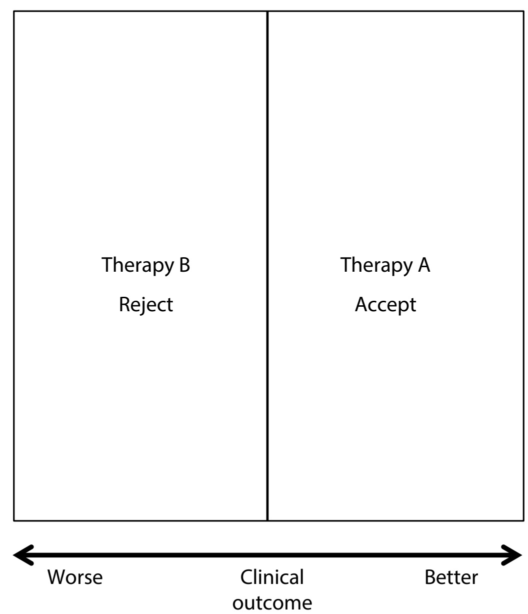


Figure 1.1 Selection of therapy on the basis of effectiveness alone.

We now live in an era of constrained health-care resources, and it is considered irresponsible to ignore cost implications when deliberating the therapeutic options for our patients. Choices must be made about how to provide the best possible care to as many patients as possible, but within a finite set of reserves. The Accreditation Council for Graduate Medical Education (ACGME) requires that accredited postgraduate programs must incorporate into their curriculum six core competencies. One of these competencies is Systems Based Practice, which includes "considerations of cost awareness and risk-benefit analysis in patient and/or population-based care as appropriate."[1] Of the seven CanMEDS competencies described by the Royal College of Physicians and Surgeons of Canada, the Manager competency includes a physician who is able to "allocate finite healthcare resources appropriately" and "apply evidence and management processes for cost-appropriate care."[2]

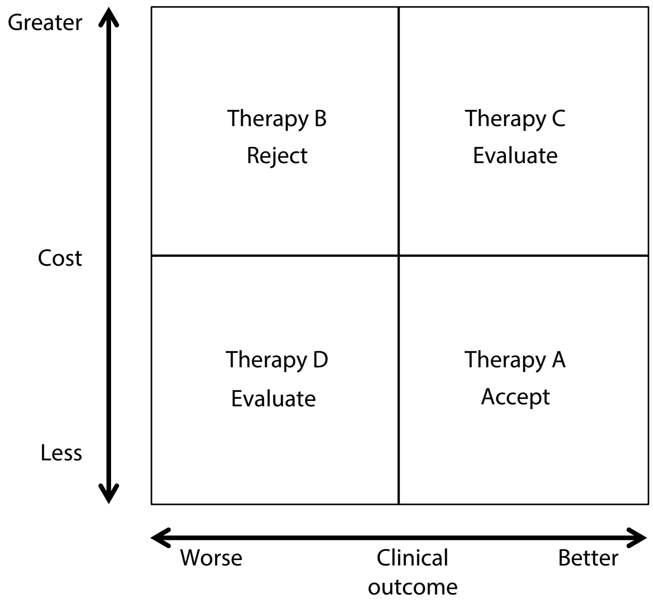


Figure 1.2 Health technology assessment considering trade-off between therapeutic effectiveness and cost.

Once we insert cost considerations into the decision-making process, we subdivide our chart into four conditions across the two dimensions of cost and effectiveness (**Figure 1.2**). **Therapy A** is generally **accepted** because it is better for patients and costs less. This is known as a dominating strategy in health economics, since trade-offs between costs and benefits are not necessary. **Therapy B** is less effective and costs more, which represents a dominating decision to **reject**. We are then left with two quadrants of the chart where the decision-making is not so clear, where competing objectives exist, and trade-offs between costs and effects must be made. **Therapy C**, which is more effective but costs more, requires an evaluation of cost-effectiveness and judgment of how much the funder is willing to pay for that additional benefit. In addition, we have **Therapy D,** which, although clinically inferior, does cost less and warrants evaluation when health-care resources are scarce.

Most economic reports in the surgical literature focus primarily on hospital costs. While these analyses are relevant to the hospital, they are less useful for determining the balance of costs to the health system throughout a patient's lifetime. Increasingly, surgical economic analyses are expanding the perspective of the economic analyses to include not only the hospital costs, but also the total cost of care including follow-up visits in the community (health system perspective or insurer perspective), and in some cases, costs related to loss of time at work or loss of productivity (societal perspective). Depending on the social context, the costs to the patient will also be relevant (patient perspective).

Most will be familiar with the generic value equation for health care, which can be expressed simply as follows:

$$Value = \frac{Quality}{Cost}$$

This can be applied to a new therapy or innovation by considering that the value of that therapy is directly proportional to the quality of care it provides and inversely proportional to the cost of that therapy.[3]

In order to provide meaningful comparison between two therapies, health economists and by extension health policy makers, in conjunction with political considerations, usually rely on the incremental cost-effectiveness ratio (ICER), typically defined by:

$$ICER = \frac{Net\ Cost}{Net\ Health\ Benefit} = \frac{Cost_A - Cost_B}{QALY_A - QALY_B}$$

where costs are expressed as the total monetary value of the inputs required, and health benefits are expressed in quality-adjusted life-years (QALYs). QALYs is a metric that is calculated by the extra length of life gained multiplied by the quality of life experienced during the remaining years of life.[4]

MINIMALLY INVASIVE COLORECTAL SURGERY: CASE STUDY

One area in which there is a wealth of data available for analysis occurs in laparoscopic colon surgery. Since the introduction of laparoscopic colon surgery in 1991,[5,6] early controversy surrounding oncologic safety has made this arguably one of the most scrutinized surgical procedures in history. As a result, a large quantity of high-level evidence is available for analysis of the differences between open and laparoscopic surgery. While we use laparoscopic colon surgery as a focus for the remainder of the chapter, many of the issues raised here will be equally applicable to other minimally invasive procedures and technologies.

Costs of laparoscopic versus open colorectal surgery

A detailed economic evaluation of laparoscopic versus open surgery for colorectal cancer from the UK perspective was reported in two papers by de Verteuil[7] and Murray.[8] This analysis modeled cost-effectiveness of laparoscopic versus open surgery over 25 years using the best available evidence at the time. The authors found that laparoscopic colon surgery was dominated by open surgery because it had similar estimated clinical effectiveness but was more costly. They concluded that laparoscopic surgery likely provides short-term quality of life benefits and similar long-term outcomes compared with open surgery but costs an additional £300 (~$390 USD) per patient. In a threshold analysis, the authors suggested that at £30,000 (~$39,000 USD) per quality life-year in the United Kingdom, laparoscopic surgery could become cost effective if it provided a benefit of at least 0.01 QALY (essentially the equivalent of 3.5 days of full health over open surgery).

In 2012, Aly and Quayyum published a systematic review of observational studies and clinical trials that reported the costs of laparoscopic and open colon surgery.[9] Their systematic review of the evidence suggested a gradual decline in the cost gap of laparoscopic surgery over open surgery with time. This decline was partially attributed to the learning curve associated with the introduction of the technology, resulting in higher costs in the near term. This eventually lessened as efficiencies in skills and technology allowed the costs of laparoscopic surgery to approach those of open colon surgery.

In a recent systematic review of the existing randomized and observational studies through 2015, we performed a meta-regression of the cost differential for laparoscopic versus open colorectal surgery and found a significant downward trend over time, which has continued to the present.[10] When we limited our meta-regression to randomized clinical trials, the reduction in cost difference between laparoscopic and open surgery was similar to that found with observational studies (**Table 1.1**).

In another assessment, we performed a retrospective cost minimization analysis of laparoscopic colon surgery versus open surgery at our institution.[19] Considering hospital costs only, we found the laparoscopic approach was associated with a net cost savings compared to open surgery. Laparoscopic right colectomy costs approximately $350 less than open surgery ($10,097.93 CAD versus $10,444.69 CAD), while laparoscopic sigmoid colectomy cost just $70 less than open surgery ($11,076.72 CAD versus $11,146.56 CAD) for the total hospital stay. This cost saving was achieved in similar fashion to other reports, by offsetting the added cost of operating room technology with downstream inpatient cost savings. Given this hospital cost savings, and associated short-term patient benefits (assuming long-term equivalence in oncologic outcomes), the laparoscopic approach dominates open surgery. However, this analysis also revealed two important considerations: This cost savings was highly sensitive to changes in equipment costs and conversions to open surgery. As a result, the cost savings measured in our institution will not necessarily automatically translate to all settings. Rather, these savings at our institution were achieved through good judgment and sensible frugality. If a case is converted to open surgery, then one incurs all of the operating room costs of a laparoscopic procedure *in addition to* open surgery, while realizing none of the downstream benefit. Furthermore, the use of a single disposable trocar (sigmoid colectomy) or an additional stapler or energy device (right colectomy) will flip the hospital cost in favor of open surgery. Good judgment on case selection is warranted, and a concerted effort to minimize operative technology cost is necessary. In our institution, and therefore represented in this analysis, is the policy that we use only reusable trocars and instruments. No energy devices or staplers are opened until we are certain that the laparoscopic approach will proceed.

What then can we say about more advanced technology such as single-port surgery or robotic-assisted surgery?

Costs of robotic-assisted versus laparoscopic versus open colorectal surgery

One randomized controlled trial (RCT) ($n = 70$ patients) compared robotic-assisted with laparoscopic right colectomy and found no proven difference in clinical outcomes or oncologic adequacy; however, operating time was increased on average by 65 minutes, and total costs were significantly increased for the hospital, the national insurance payer, and the patients. The extra costs were attributed primarily to the costs of surgery and consumables.[18]

A number of systematic reviews and meta-analyses have compared clinical outcomes and costs of robotic colorectal surgery versus laparoscopic or open surgery, including observational studies and the single existing RCT described above. Three separate systematic reviews found robotic colorectal surgery to be associated with longer operation times and increased costs with minimal clinical benefit.[20–22]

Overall, the evidence to date suggests that the additional costs associated with robotic colorectal surgery, when compared to laparoscopic or open surgery, have not been justified by offsets in downstream costs or by improved clinical outcomes for patients. As a result, many have proposed that

Table 1.1 RCTs of laparoscopic versus open colon surgery providing cost data

Trial	Perspective	Cost		Difference	Percentage (%)
		Open	Laparoscopic		
Braga et al.[11]	Hospital	€4826[a]	€4951[a]	€125	2.6%
Franks et al.[12]	Societal	£6631	£6899	£268	4.0%
Janson et al.[13]	Hospital	€7235	€9479	€2244	31.0%
King et al.[14]	Societal	£6787	£6433	(£353)	(5.2%)
Leung et al.[15]	Hospital	$9850	$9729	($121)	(1.2%)
Norwood et al.[16]	Operating room	$9948 AUS	$10,111 AUS	$163 AUS	1.6%
Zheng et al.[17]	Hospital	10,228 CNY	11,499 CNY	1271 CNY	12.4%
		Robotic	Laparoscopic		
Park et al.[18]	Societal	$12,235 USD	$10,320 USD	($1915)	(15.6%)

[a] Calculated.

the uptake of robotic surgery should be done only within the context of formal clinical trials to guide future areas for uptake, and to assess whether mitigation of the learning curve, or whether competency-based expertise will allow for achieving acceptable cost-effectiveness.

Costs of single-incision laparoscopic surgery, laparo-endoscopic single-site surgery, natural orifice transluminal endoscopic surgery

Single-incision laparoscopic surgery (SILS), laparo-endoscopic single-site (LESS) surgery, and natural orifice transluminal endoscopic surgery (NOTES) can be considered the extreme of minimally invasive therapy. A number of observational studies have evaluated whether tangible clinical and economic benefits of SILS or NOTES over conventional laparoscopic surgery are found for colorectal surgery. However, the bias inherent in these existing observational studies and meta-analyses of these observational studies preclude definitive conclusions.[23] RCTs with adequate power and follow-up will be required before the incremental cost-effectiveness ratio can be defined. As with most new technologies in the early stages, newly released sophisticated trocars and other dedicated instruments added significant costs to the operating procedure. With increased experience, industry competition, and use of conventional instruments, the costs of technologies for SILS have decreased.[24] In a retrospective cost analysis of 260 patients, Stewart et al. reported similar total patient charges ($34,847 versus $38,306; $p > 0.05$) or hospital costs ($13,051 versus $12,703; $p > 0.05$) for single-site versus conventional laparoscopy, respectively.[25] Only a demonstration of improved clinical outcomes in randomized studies and/or reduced costs will ultimately render SILS cost effective compared with conventional approaches.

SPECIAL CONSIDERATIONS FOR COST ANALYSES AND COST-EFFECTIVENESS ESTIMATES IN LAPAROSCOPIC AND ROBOTIC SURGERY

There is great heterogeneity in estimates of the costs for laparoscopic, robotic, and open surgery. This is not unique to colon and rectal surgery. Reasons for this heterogeneity are related to differences in the types of costs incorporated in the estimates provided within these studies, differences in time horizons of the evaluation, and the perspective of the analysis. In general, the studies are in agreement that laparoscopic techniques incur additional technologic costs compared with open surgery. As we continue to push the frontier of what can be accomplished in a minimally invasive fashion, it is important to consider that technology costs will continue to be the most significant driver when clinical benefits are small.

With the exception of de Verteuil and Murray et al.,[7,8] all of the costing studies referred to in this chapter were cost analyses only without attempting to calculate the ICER. These provide partial estimates of the comparative cost side of the ICER only, without providing estimates of the incremental benefit, such as QALYs. This is likely due to the paucity of proof of large differences in clinical benefit. As a result, most ICERs, if calculated, would be extremely high, due to the very small size of the denominator. Future economic analyses should focus on providing a full economic perspective, with incremental costs (comprehensively defined) *and* incremental benefits defined. This will significantly advance our ability to make better decisions about committing resources and improve understanding of the trade-offs and opportunity costs among minimally invasive options for surgery.

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2

Enhanced recovery programs in minimally invasive surgery

NICOLÒ PECORELLI AND LIANE S. FELDMAN

INTRODUCTION

Improving recovery for patients through reducing surgical trauma is a key goal of minimally invasive surgery. It is well understood that the negative consequences of surgery, including pain, organ dysfunction, catabolism, fluid/salt retention, and sleep disturbances are proportional to the degree of tissue injury and the resulting surgical stress response.[1] The mechanisms of surgical stress are very complex including a systemic inflammatory response mediated by pro-inflammatory cytokines and metabolic changes mediated by endogenous catecholamine and steroid release leading to increased insulin resistance and protein catabolism.[2] Digestive surgery involves two separate wounds: one in the abdominal wall and one to the peritoneum and viscera, each triggering a systemic neurohumoral response.[3] When the major trigger of the stress response is the abdominal wall incision, the benefits of laparoscopy are obvious. When the laparoscopic revolution began in the early 1990s, surgeons were immediately struck by how much better their patients looked after laparoscopic compared to open cholecystectomy. Patients undergoing cholecystectomy, fundoplication, and colonic and bariatric procedures now require hospital stays shorter than 24 hours. These results would be difficult to imagine after open surgery.

But even when the length of stay is short, full functional recovery takes weeks or months.[4] With colon surgery, full physical recovery is not complete even 2 months postoperatively.[5] Complications of abdominal surgery remain relatively high,[6] and complications further delay patient recovery.[7] Perioperative care is a complex intervention made up of multiple smaller interventions, each of which has the potential to improve or delay patient recovery and influence outcomes. In addition to minimally invasive surgery (MIS), multiple other interventions are available that reduce metabolic stress through a variety of mechanisms.[8,9] Some in clinical use include pharmacologic (afferent neural blockade using local anesthetics, glucocorticoids, intravenous local anesthetics, and nonsteroidal anti-inflammatory drugs [NSAIDs]), nutritional (preoperative carbohydrate and immediate postoperative feeding), physical (maintaining normothermia, euvolemia, and physical exercise), and hormonal (glycemic control). Guidelines for optimal perioperative care in colon, rectal, gastric, and pancreatic surgery[10–13] include up to 25 evidence-based recommendations from all phases of perioperative care, involving multiple stakeholders (surgery, anesthesia, nursing, and patients). It is clear that as surgeons, if we only focus on the operation without being concerned with all of the other interventions our patients receive along the perioperative trajectory, our patients will not derive the maximal potential benefit of the minimally invasive approach. Even if the perfect laparoscopic bowel resection is performed, the impact will be much less if the patient comes out of the operating room hypothermic, fluid overloaded, and in pain. That patient is subsequently unlikely to be ready to eat or ambulate quickly, leading to more deconditioning and delaying full functional recovery.

In 1995 a Danish group led by Henrik Kehlet published a report on nine patients undergoing laparoscopic colonic resection who were treated with a multimodal intervention program including epidural analgesia, early oral nutrition, and mobilization.[14] This was the first step for the development of fast-track programs, which later evolved into what are currently known as enhanced recovery pathways (ERPs). ERPs are evidence-based, multimodal, standardized care plans that integrate the multiple steps and interventions in the perioperative period. They aim to reduce the metabolic response to surgery in multiple ways,[9] but also to better organize care for patients undergoing a particular procedure, and thereby contribute to reducing unwanted variability in care processes and outcomes. A meta-analysis of 38 trials across multiple specialties concluded that ERPs reduced the risk of complications by about 30% and were associated with reduced hospital stays by about 1 day overall.[15] The impact was consistent across specialties, which included colorectal, upper gastrointestinal, genitourinary, thoracic, and joint surgery. The approach also decreases costs, especially for the entire trajectory of perioperative care including posthospital costs.[16–17] Including MIS as the foundation of an ERP and considering the entire care trajectory, from the preoperative phase through to full patient functional recovery, maximizes the value of the laparoscopic approach and its higher operating room equipment costs.

In this chapter, we first describe elements included in ERPs. We then review the evidence regarding the relative benefit of MIS and enhanced recovery on postoperative recovery. Finally, we provide an example of an ERP for bowel surgery to help others adopt this approach.

COMPONENTS OF ENHANCED RECOVERY PROGRAMS

ERPs represent a paradigm shift, from traditional care where the patient moves from one clinician-based expertise silo to the next, to a patient-centered pathway, where the steps of perioperative care are integrated. Interdisciplinary collaboration involving credible champions from surgery, anesthesiology, and nursing who will promote implementation with their constituencies is required. Creation of a new ERP begins by the team mapping out the trajectory of perioperative care at their institution and reviewing existing guidelines for each element of perioperative care, such as those from the Enhanced Recovery After Surgery (ERAS) Society.[10–13] There are some elements that are common across a variety of procedures and some that are procedure specific, but the approach can be applied to any procedure (**Table 2.1**). The number of elements in a program per se does not seem to be critical, and success measured by a shorter hospital stay and complications has been seen with both complex and simpler programs.[15,18] While the specific ways in which these elements are approached may vary from center to center, what seems most important is to come together as a team to create a multidisciplinary consensus for each element and from each phase of perioperative care about "how we're going to do it at our hospital" for the average patient.

Daily care maps help with adherence as they provide consistency between the information received by patients and the health-care team. Beginning in the surgeon's clinic and continuing with the preoperative clinic education, the patient and the patient's family are provided with the daily plan for each day of hospitalization. This includes specific daily goals for nutrition, mobilization, drain management, and pain control, as well as milestones to reach to enable discharge (**Figure 2.1**). When all of the recovery milestones are met, patients generally feel very comfortable leaving the hospital, even if this is earlier than with traditional care. Patients are encouraged to bring the information with them to the hospital, and the care maps are also posted on the ward. Patients are encouraged to speak up and ask questions about their own recovery trajectory and play an active role.

Table 2.1 Key elements to include in ERPs for gastrointestinal surgery

Preoperative	Optimization of organ dysfunction
	Patient education and engagement
	Prehabilitation/exercise
	Smoking abstinence
	Nutrition assessment/supplement
	Selective bowel preparation
	Limit preoperative fasting
	Carbohydrate drink
	No long-acting sedative
Intraoperative	Postoperative nausea and vomiting (PONV) prophylaxis
	Fluid therapy to achieve fluid balance
	Nerve block (when evidence based)
	Minimally invasive surgery
	Short-acting opioids
	Normothermia
Postoperative	Multimodal opioid-sparing analgesia (evidence based, procedure specific)
	Anti-ileus prophylaxis
	PONV prophylaxis
	Question use of drains, catheters, and monitoring (evidence based)
	Immediate or early oral nutrition
	Immediate ambulation
	Daily care maps, well-defined discharge criteria
	Postdischarge rehabilitation plan (evidence based)

Source: Kehlet H. *Langenbecks Arch Surg* 2011;396(5):585–90.[62]

Note: This approach is applicable across procedures, but how each element is operationalized may differ depending on the available evidence for that procedure as well as available local expertise.

As with any quality improvement initiative, having data about both processes and outcomes is critical. Data collection should ideally begin when the ERP team is assembled, to show the team where they are starting. Length of stay (LOS) is an easy way to monitor outcomes within an institution as it relates to recovery, organization, complications, and cost. Readmissions and emergency department visits should also be monitored. However, it is also important to collect information about adherence to the different care processes that will be included in the ERP in order to understand those outcomes and how to improve care.

When creating a pathway for bowel surgery, key elements to address include preoperative patient education/

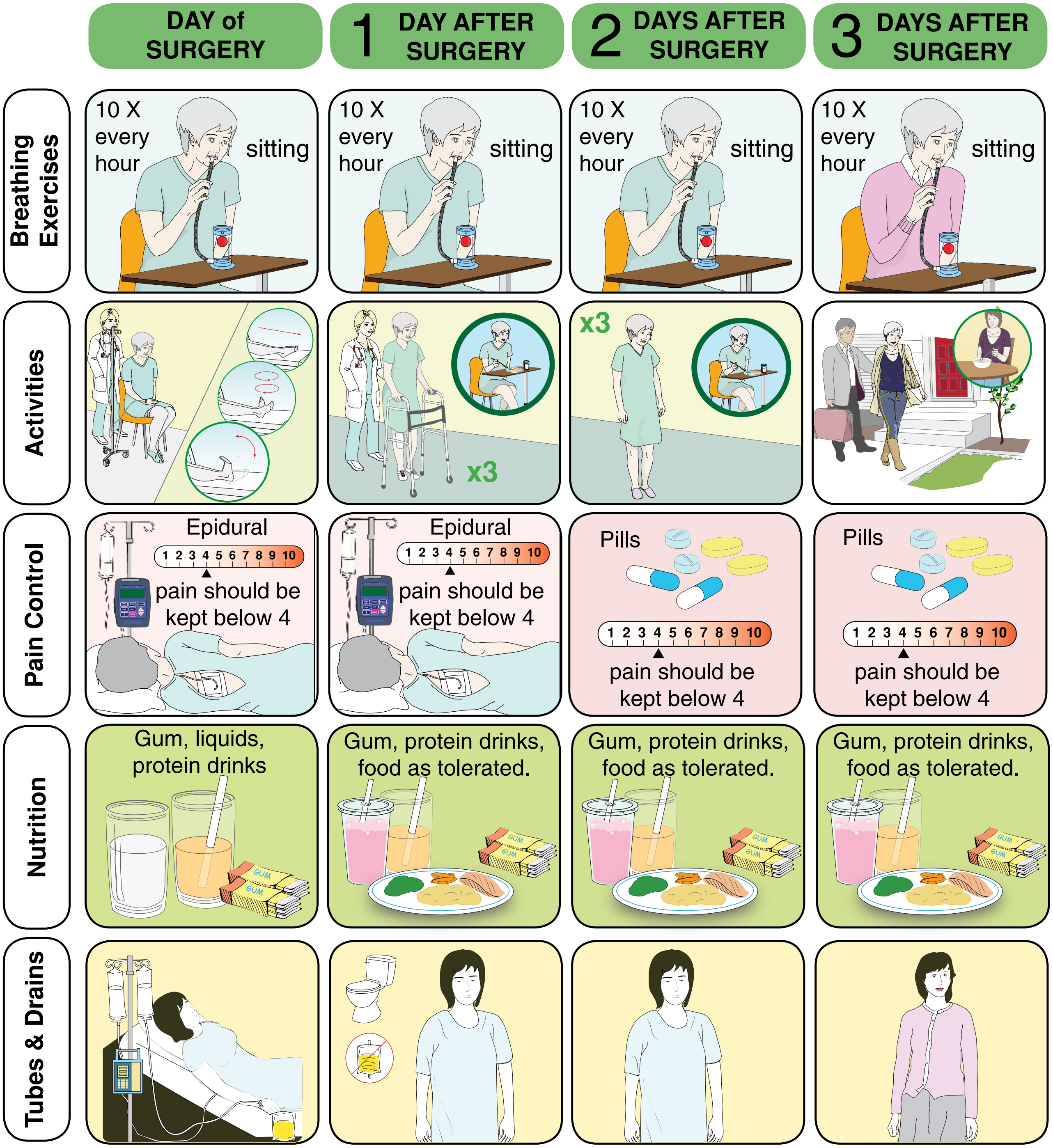

Figure 2.1 Example of daily care plan provided to the patient in an ERP for bowel surgery. (Used with permission of the MUHC patient information office.) (*Continued*)

engagement, nutrition, fluid balance, opioid-sparing analgesia, exercise/mobilization, and use of drains. However, most of the evidence in the guidelines was from studies of open surgery. The significant role of MIS in reducing pain, ileus, and the inflammatory response means that some of the ERP objectives will be achieved differently for open and laparoscopic surgery. For example, thoracic epidural analgesia is strongly recommended for open surgery[11] but may delay recovery after laparoscopic surgery,[19] and simpler approaches, such as transversus abdominis plane (TAP) blocks, have been used successfully.[20] Similarly, for higher-risk patients undergoing major surgery, goal-directed fluid therapy using cardiac output monitoring is recommended, but in the context of laparoscopic surgery within an ERP,

Path to Home Guide: Bowel Surgery

	Day of surgery	1 Day after Surgery	2 Days after Surgery	3 Days after Surgery
Breathing Exercises	• Do breathing exercises	• Do breathing exercises	• Do breathing exercises	• Do breathing exercises
Activities	• Do leg exercises • Sit in a chair with help	• Sit in a chair for meals • Walk in the hallway 3 times, with help • Be out of bed for a total of 6 hours	• Sit in a chair for meals • Walk in the hallway 3 times • Be out of bed for a total of 6 hours	• Sit in a chair for meals • Be out of bed for a total of 6 hours • Go home today
Pain Control	• May have an epidural infusion for pain • Tell my nurse if pain reaches 4/10 on the pain scale	• May have an epidural infusion for pain • Tell my nurse if pain reaches 4/10 on the pain scale	• Start taking pills for pain • Have epidural catheter removed if my pain is controlled • Tell my nurse if pain reaches 4/10 on the pain scale	• Tell my nurse if pain reaches 4/10 on the pain scale
Nutrition	• Drink liquids and protein drinks as tolerated • Chew gum for 30 minutes	• Drink liquids, including protein drinks • Eat regular food as tolerated • Chew gum for 30 minutes, 3 times/day	• Drink liquids, including protein drinks • Eat regular food as tolerated • Chew gum for 30 minutes, 3 times/day	• Drink liquids, including protein drinks • Eat regular food as tolerated • Chew gum for 30 minutes, 3 times/day
Tubes & Lines	I may have: • Oxygen mask or prongs (removed today) • Intravenous line • Epidural catheter • Urinary catheter	• My urinary catheter may be removed today • My intravenous line will be removed when I am drinking well	• My urinary catheter will be removed today, if it wasn't removed yesterday • My intravenous line will be removed when I am drinking well • My epidural catheter will be removed and my pain will be managed with pills	• None

Figure 2.1 (Continued) Example of daily care plan provided to the patient in an ERP for bowel surgery. (Used with permission of the MUHC patient information office.)

similar results may be obtained using a simpler restrictive fluid approach.[21]

COMBINING LAPAROSCOPIC SURGERY WITH AN ERP

Both laparoscopic surgery and ERPs result in improved outcomes when used in isolation. Some elements of the ERP approach are already used more readily after laparoscopic surgery, such as early feeding. Are there advantages, beyond the theoretical, in adding a multidisciplinary ERP to a laparoscopic operation? In the following sections evidence regarding the relative benefit of MIS and enhanced recovery on postoperative recovery in different general surgery subspecialties is reviewed. This is in the form of a narrative review synthesizing studies found through literature searches performed in early 2015 using various combinations of "laparoscopic" or "minimally invasive" with "Enhanced recovery" or "Fast track" surgery.

Colorectal surgery

Two types of study designs have been used to evaluate the relative impact of MIS and ERP on recovery in the setting of colorectal surgery: (1) studies comparing open and laparoscopic surgery for patients treated within an ERP and (2) studies comparing conventional perioperative care to enhanced recovery in patients undergoing laparoscopic resection. Five randomized clinical trials (RCTs)[22–26] compared laparoscopic versus open surgery when an ERP is in use (**Table 2.2**). Two early studies were single-center trials with a relatively small sample of patients and yielded contrasting results. Kehlet's group found no difference in length of hospital stay, postoperative complications, gastrointestinal function, or patient-reported outcomes after open or laparoscopic colectomy when treated with enhanced recovery,[22] suggesting that when an ERP is used, the benefits ascribed to laparoscopy could be achieved with open surgery. In contrast, Kennedy's group reported improved LOS, lower pain scores, and greater physical performance 2 weeks after laparoscopic compared to open surgery.[23]

Two large multicenter RCTs were subsequently published: the LAFA study in the Netherlands,[24] and the EnRol trial in the United Kingdom.[26] The LAFA study allocated 400 patients undergoing colonic segmental resection for cancer to one of four groups combining surgical approach (laparoscopic or open) and perioperative care (enhanced recovery or standard). The combination of laparoscopy and enhanced recovery resulted in shorter length of hospital stay compared to the other groups, with laparoscopy the only independent predictor of reduced length of hospital stay. No differences were found for secondary outcomes including morbidity and quality of life. In a subset of patients, gastrointestinal recovery as measured by scintigraphy was faster in patients

Table 2.2 Characteristics and outcomes of randomized controlled trials evaluating laparoscopic versus open colorectal surgery within an enhanced recovery pathway

Study	Sample size		Type of surgery	Primary outcome	Postoperative morbidity			Total hospital stay			Readmissions		
	Lap	Open			Lap	Open	*P*-value	Lap	Open	*P*-value	Lap	Open	*P*-value
Basse et al.[22]	30	30	Colon	Length of stay	8 (27%)	6 (20%)	>0.05	Mean 3.8	Mean 3.9	>0.05	6 (20%)	8 (27%)	>0.05
King et al.[23]	41	19	Colorectal	Length of stay	6 (15%)	5 (26%)	0.21	Mean (95%CI) 5.5 (4–7)	Mean (95%CI) 8.3 (6–11)	0.012	2 (5%)	5 (26%)	0.027
LAFA[24]	100	93	Colon	Length of stay	34 (34%)	43 (46%)	>0.05	Median (IQR) 5 (4–7)	Median (IQR) 6 (4.5–10)	0.005	6 (6%)	7 (8%)	>0.05
Wang et al.[25]	40	41	Colon	Immune function	3 (8%)	7 (17%)	>0.05	Mean (SD) 5.2 (3.9)	Mean (SD) 6.5 (4.1)	<0.05	1 (3%)	3 (7%)	>0.05
EnRol[26]	103	101	Colorectal	Fatigue	32 (31%)	36 (36%)	0.55	Median (IQR) 5 (4–6)	Median (IQR) 6 (4–9)	0.011	14 (14%)	10 (10%)	0.38

Note: CI, confidence interval; IQR, interquartile range; Lap, laparoscopy; SD, standard deviation.

treated with laparoscopic surgery and enhanced recovery compared to the other groups. Both laparoscopy and enhanced recovery were independent predictors of faster colonic transit, earlier time to tolerance of solid food, and defecation.[27] Immune status and stress response after surgery were evaluated in another subset of patients from the LAFA trial.[28] Laparoscopy and not the type of perioperative care was an independent factor of better-preserved immune competence and reduced inflammation. In a randomized study with a design similar to the LAFA trial, Wang et al.[25] confirmed that the inflammatory response was attenuated in patients treated with MIS compared to open surgery, while enhanced recovery similarly protected immune function in both laparoscopic and open surgery patients.

Finally, in the EnRol trial,[26] 204 patients planned for colorectal resection were randomized to open or laparoscopic surgery in 12 UK centers applying an extensive ERP with 30 care elements and blinding of patients and assessors. LOS was shorter with laparoscopy, but no other differences were seen for physical fatigue, body image, and quality of life 1 month after surgery. The authors concluded that laparoscopic surgery within an ERP is recommended because of the shorter hospital stay. Zhuang et al.[29] recently published a meta-analysis including the aforementioned studies. Pooled data revealed that total hospital stay including postdischarge readmissions was significantly shorter in patients who underwent a laparoscopic procedure. The total number of complications was also reduced for laparoscopy, while no difference was found between open and laparoscopic surgery for the number of patients developing at least one complication.

Several randomized trials[30–35] and a larger number of case control studies[36–43] have estimated the effect of enhanced recovery compared to conventional care when minimally invasive colorectal resection is performed. All but one study[30] reported that the implementation of an ERP in the context of MIS reduces LOS and accelerates recovery of gastrointestinal function. These findings are confirmed by larger case control studies from high volume institutions and a few available case match studies. A report from the Mayo Clinic[37] showed that 45% of patients treated within an ERP were discharged within 2 days after minimally invasive colorectal cancer surgery. Postoperative complications were similar between ERP patients and conventional care in most of the RCTs and nonrandomized studies. Focusing on economic analysis, in a prospective comparative trial where most patients had laparoscopic resections,[16] the addition of an ERP resulted in lower societal costs compared to a conventional care strategy. After discharge, patients managed in the ERP institution incurred less productivity loss, had less caregiver burden, and made fewer visits to outpatient health centers. A recent Cochrane review of three RCTs and six case-controlled studies found that for patients having laparoscopic colectomy, the addition of an ERP reduced LOS without affecting morbidity.[44] In a large multicenter registry, increasing adherence with pathway elements and the use of laparoscopic surgery were both independently associated with shorter hospitalization and complications.[45]

Although the quality of the evidence is not uniformly high, the data suggest that for colorectal resection, combining minimally invasive surgery with an ERP offers the greatest benefit, both for patients and for the health-care system. To date, most of the studies have only focused on short-term in-hospital recovery outcomes such as LOS and morbidity,[46] and future studies should also include postdischarge functional recovery measures to better capture all dimensions of recovery both in the short and longer term.[47]

Bariatric and foregut surgery

There are very few reports investigating the effectiveness of a formal multidisciplinary ERP in bariatric surgery. However, there are numerous reports about ambulatory bariatric surgery. McCarty et al.[48] reported 23-hour discharge in 84% of 2,000 consecutive patients undergoing laparoscopic Roux-en-Y gastric bypass (RYGB), with few complications and readmissions. In this very high volume group with low leak rates, this was accomplished by simple optimization of perioperative analgesia and early return to oral feeding; the most significant factor in predicting successful 23-hour patient discharge was surgeon experience. Similar results were reported in a systematic review including six series of RYGB patients and eight series of laparoscopic gastric banding patients with planned outpatient surgery.[49] However, a recent population-based study including more than 50,000 laparoscopic RYGB patients from the Bariatric Surgery Centers of Excellence database has raised concerns about increased risk of 30-day mortality and a trend toward increased risk of 30-day serious complications in patients with a LOS of 1 day or less.[50] Only a few studies have reported on the use of multidisciplinary ERPs for bariatric surgery. These suggest that for laparoscopic RYGB and sleeve gastrectomy, ERPs facilitate early discharge without increasing complication and readmission rates.[51,52]

The use of enhanced recovery strategies in the context of minimally invasive gastric surgery is limited to a few studies. Grantcharov and Kehlet[53] found that an ERP was feasible and safe resulting in short hospital stays (median LOS was 4 days) in a consecutive series of patients undergoing laparoscopic gastric resection for cancer. Two small RCTs comparing ERP to conventional care in laparoscopic distal gastrectomy patients have been published.[54,55] Although underpowered to detect differences in postoperative morbidity, both studies showed reduced hospital stays in the ERP group compared to conventional care, and one also found that enhanced recovery was associated with improved quality of life at 2 weeks after surgery.[54]

Hepato-Pancreato-Biliary (HPB) Surgery

Few studies have focused on the role of enhanced recovery in laparoscopic liver surgery. In a case-control series, patients

Table 2.3 Example of a multimodal ERP for elective colorectal surgery

Preoperative Assessment and Optimization

- Evaluation of medication compliance and control of risk factors: hypertension, diabetes, chronic obstructive pulmonary disease (COPD), smoking, alcohol, asthma, coronary artery disease (CAD), malnutrition, anemia
- Psychological preparation for surgery and postoperative recovery: provide written information and e-module link including daily milestones in perioperative pathway (diet and ambulation plan, management of drains) and expectation about duration of hospital stay (3 days for colon, 4 days for rectal)
- Physical preparation with exercises at home: aerobic 30 minutes/day, three times per week at moderate intensity; resistance exercises; breathing exercises
- Full oral mechanical bowel preparation with oral antibiotics for rectal resections; no prep for laparoscopic colectomy; stoma teaching as needed
- Nutritional preparation: oral nutritional supplements for patients with diminished oral intake or mild malnutrition

Day of surgery

- Drink clear fluids with carbohydrates up to 2 hours prior to operation unless risk factors are present (e.g., gastroparesis, obstruction, dysphagia, previous difficult intubation, pregnancy)

Intraoperative Management

Anesthetic management

- Epidural catheter for open cases inserted at appropriate intervertebral level. Use local anesthetics and test epidural blockade for bilateral spread. Infusion of local anesthetics during surgery. Minimal amount of IV opioids throughout surgery. Intrathecal morphine as alternative for laparoscopic surgery
- Bilateral transversus abdominis plane (TAP) block with ketorolac IV for laparoscopic surgery
- Prophylactic antiemetics: one or more antiemetics based on baseline risk score
- Antibiotics and deep vein thrombosis (DVT) prophylaxis
- Avoid overhydration. IV Ringer lactate at 3 mL/kg/h for laparoscopic surgery; 5 mL/kg/h for open cases. Colloid 1:1 (Voluven) to replace blood loss
- Anesthesia protocol: total IV anesthesia (tiva)/desflurane/sevoflurane. Lidocaine 1.5 mg/kg bolus then 2 mg/kg/h for duration of case (in patients without epidural)
- Maintenance of normothermia (core temperature $>36°$)
- Neuromuscular blockade to facilitate laparoscopic exposure at lower pressure pneumoperitoneum (12 mmHg)
- Maintain glucose below 10 mmol/L (180 mg/dL)
- Titrate anesthesia according to bispectral index

Surgical care

- Minimize incision size, minimally invasive approach if possible
- Accurate hemostasis and removal of debris
- Check integrity of anastomosis
- No routine nasogastric and abdominal drains
- Remove urinary catheter for right hemicolectomy

Postoperative Strategy

Postanesthesia care unit

- Discharge criteria to ward: patient alert, cooperative, pain-free, warm, normotensive, able to lift legs, adequate urine output

Day of surgery (postoperative day 0)

- Out of bed when transferred to ward
- Drinking fluids including nutritional supplements. Hold oral intake if abdomen distended or nausea/vomiting
- Confirm working epidural with visual analog scale (VAS) for pain at rest, cough, and mobilization. Check skin site (repeated in subsequent days)
- Oral acetaminophen 650 mg every 4 hours and Celecoxib 200 mg PO BID $\times$ 72 hours then reassess
- Normal saline to keep vein open (30 mL/h) if has patient controlled analgesia (PCA)
- Gum chewing for 30 minutes TID (continue daily)

Postoperative day 1

- HepLock IV in morning of POD 1
- Urinary catheter removed in the morning
- Mobilized 4–6 hours
- Full oral diet including nutritional supplements
- Hold oral intake if abdomen distended. Nasogastric tube for persistent nausea and vomiting (repeated in subsequent days)

(*Continued*)

Table 2.3 (*Continued*) Example of a multimodal ERP for elective colorectal surgery

Postoperative day 2 and later (>48 hours)
• Full mobilization
• Full oral diet including nutritional supplements
• Transition from epidural to oral medication (OxyContin + oxycodone + acetaminophen + NSAIDs) if epidural stop test successful (repeated in subsequent days if epidural stop test not successful)
• Discharge criteria: passing gas or stool, no fever, minimal pain (<4/10), walking unattended, eating
Postdischarge care
• Instructions while recovering at home and/or on chemotherapy/radiotherapy: eating normal diet (±supplements), exercise every day, avoid opioids for pain relief, psychological support
• Clinic visit postop day 14 to check wound and overall recovery. Discuss pathology and further treatment. Plan further follow-up

Source: Feldman LS et al. *ACS Surgery* 2013.[63]

treated with an ERP were considered functionally recovered and achieved discharge criteria earlier compared to conventional care.[56,57] A Dutch RCT (Orange II)[58] evaluating functional recovery following laparoscopic versus open left lateral liver resection within an ERP has recently been completed, but the results have not yet been reported.

In pancreatic surgery, where MIS is frequently adopted for both benign and malignant lesions of the distal pancreas, a few studies have also incorporated ERPs. A case-matched series including 100 patients undergoing laparoscopic distal pancreatectomy found that laparoscopy was associated with faster recovery of gastrointestinal function and significantly shorter LOS for uncomplicated patients compared to open surgery.[59] A smaller case-control series of 44 patients undergoing laparoscopic distal pancreatectomy reported that the implementation of an ERP was associated with faster return to normal gut function, reduced LOS, and cost saving compared to conventional care.[60]

SAMPLE ERP FOR LAPAROSCOPIC BOWEL SURGERY

Excellent guidelines and reviews[10–13,61] are available to aid clinicians in developing their own programs, and many adjust the recommendations for laparoscopic or open surgery. These guidelines make it clear that many elements are under the purview of anesthesiology and nursing whose participation is critical in ERP implementation. An example of an ERP for bowel surgery is provided in **Table 2.3**.

CONCLUSIONS

Some surgeons may feel they are already providing enhanced recovery care to their patients after laparoscopic surgery by feeding patients early, encouraging early mobilization, and minimizing the use of drains. However, implementation of an ERP requires anesthesiologists, nurses, and patients to integrate care, introduce new approaches, and stop doing some things that are detrimental. While it is true that some interventions in an ERP are not traditionally in the purview of the surgeon, bringing a team together around a patient certainly is and hopefully always will be.

Adopting a culture of enhanced recovery has benefitted our institution in many ways. Adding an ERP helps maximize the value of laparoscopic procedures by decreasing costs and improving outcomes. Decreasing the LOS increases capacity. Creating ERPs requires a multidisciplinary team and facilitates discussions around quality. Fasting guidelines that were implemented in association with ERPs are now standard procedures, as is the bladder-scan protocol for urinary retention. Increased attention on the patient's role in recovery encourages a culture where people can speak up and be engaged in their own care.

Many surgical specialty organizations now promote adoption of ERPs, including the American College of Surgeons, by including ERP process measures as optional data collection in the colorectal-specific National Surgical Quality Improvement Program. The Society of American Gastrointestinal and Endoscopic Surgeons established an enhanced recovery task force to create the SMART (Surgical Multimodal Accelerated Recovery Trajectory) program. Through courses, workshops, the webpage, and a manual written in collaboration with the ERAS Society, SMART will promote the adoption of patient-centered enhanced recovery care principles that enhance the intrinsic benefits of minimally invasive surgery to further improve safety, efficiency, and outcomes.

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SECTION II

Flexible endoscopy

Warren and Lucia Prosperi, *Ether Day, 1846*, 1999–2001. Oil on canvas, 72 × 96 inches. Massachusetts General Hospital, Boston. (Image courtesy Massachusetts General Hospital, Archives and Special Collections.)

The first surgical operation utilizing ether anesthesia took place at Massachusetts General Hospital (MGH), Boston, on October 16, 1846, in a surgical theater now known as the "Ether Dome." This painting, made by husband-and-wife team Warren and Lucia Prosperi between 1999 and 2001, is based on a reenactment of this historic event in the Ether Dome. The Prosperis researched for more than a year into the lives of the men involved, including dentist Dr. William Thomas Green Morton, who holds the flask of ether; surgeon Dr. John Collins Warren, who makes the incision; and patient Edward Gilbert Abbott, who was afflicted by a vascular tumor in his neck. The painting shows the fateful moment when the first painless incision was made into Abbott's throat by Dr. Warren.

In this work, the Prosperis employed a technique called optical naturalism to depict the event with photographic realism. The perspective of this painting places the viewer to the side of the action, as if a member of the audience, where we have an overview of the patient, surgeons, and observers. Thus, we are granted an experience similar to those attending operations in the same space today. The Prosperis restaged the event utilizing models from Harvard Medical School and MGH for the historical figures, including Drs. Warren M. Zapol and J. Philip Kistler for Morton and Warren, respectively. With the help of the Emerson College Theatre Department, which did the costuming and makeup, and original props from the hospital museum, the Prosperis photographed the scene in the Ether Dome in order to create studies for the final painting. The work was then painted on site in the theater—now a lecture hall—where the painting still hangs to this day.

3

Training and privileging surgeons and gastroenterologists in endoscopy

JUDY WANG AND BRIAN J. DUNKIN

INTRODUCTION

The natural advancement of surgery is to become less invasive and more accurate. Amazing developments have occurred over the last three decades to move from open surgery to minimally invasive to endoluminal across multiple surgical disciplines. In gastrointestinal (GI) surgery, this has resulted in a resurgence of surgeons performing procedures using a flexible endoscopic platform, either as an adjunct to surgery, or to replace it.

Unfortunately, the history of the role surgeons have played in developing therapeutic endoscopy has been forgotten, and surgical training in endoscopy has not traditionally been strong. As a result, some have called into question the qualifications of surgeons performing flexible GI endoscopy.

This chapter provides a brief history of the role surgeons have played in developing GI endoscopy, a review of surgical and medical training pathways in the field, and guidance on the granting of privileges to perform the procedures.

HISTORICAL ROLE OF SURGEONS IN FLEXIBLE GASTROINTESTINAL ENDOSCOPY

Surgeons have played an integral role in the creation of endoscopic techniques dating back to the nineteenth century. In 1853, the French urologist A. J. Desormeaux created a device that could be used to evaluate the interior of the urethra and bladder, and the term "endoscope" was coined.[1] In 1868 the German surgeon Adolph Kussmaul fashioned a metal pipe used to examine the esophagus and stomach. Unfortunately, the light illumination was not sufficient. However, in 1879, the German urologist Maximilian Nitze and the Austrian electrical engineer Joseph Leiter made a cystoscope using an electric light source and, with continued advancements, were able to construct a modern esophagoscope and gastroscope.[2] In 1881, Jahann Mikulicz-Radecki, a Polish-Austrian surgeon working for Theodore Billroth, created, with the help of Leiter, a rigid gastroscope with a curved distal tip and attached mirrors to create a 30° angle field of view. Using this device, Mikulicz was the first to describe the endoscopic view of a gastric carcinoma and perform the endoscopic removal of a bone obstructing the esophagus by pushing it into the stomach.[3] By 1911 Henry Elsner had developed a semiflexible gastroscope that Rudolph Schindler, an army surgeon, used to pioneer the field of gastroscopy and publish an atlas of his findings in 1923.[4]

In 1930, Heinrich Lamm, a gynecologist, demonstrated that an image could be transmitted across a coherent fiber-optic bundle, thus ushering in the era of fiber-optic endoscopy. By 1968 the first endoscopic retrograde cholangiopancreatography (ERCP) was reported by William McCune, a surgeon at George Washington University Hospital in Washington, DC.[5] A year later, Wolff and Shinya, a Japanese-born, U.S.-trained surgeon, performed the first snare colonic polypectomy.[6] By 1980, Jeff Ponsky, a general surgeon, and Michael Guaderer, a pediatric surgeon, had developed the percutaneous endoscopic gastrostomy (PEG) tube.[7] In 1988, Greg Stiegmann, a surgeon in Denver, Colorado, described variceal band ligation.[8] In 2007, David Utley, an ear, nose, and throat surgeon, and George Triadafilopoulos, a gastroenterologist, teamed up to invent Stretta—the first endoluminal treatment for gastroesophageal reflux disease to be approved by the U.S. Food and Drug Administration. Utley would later go on to pioneer radiofrequency ablation of the esophageal mucosa for the treatment of Barrett esophagus—a technique that has essentially replaced esophagectomy for the management of dysplastic Barrett esophagus.[9] By 2010, Haru Inoue, a Japanese surgeon, published the first experience in performing natural orifice surgery for achalasia—the peroral endoscopic myotomy (POEM).[10] Today, POEM is rapidly replacing Heller myotomy as the preferred treatment for achalasia.

Surgeons have played a role in pioneering every significant advancement in therapeutic endoscopy. Not only have they earned the right to perform these procedures, but they need them to advance the field of minimally invasive surgery (MIS).

TRAINING IN GI ENDOSCOPY

Both surgeons and gastroenterologists use flexible endoscopy to provide optimal patient care for GI diseases. This training is most often gained during a general surgery residency, colon and rectal surgery residency, or gastroenterology fellowship. Training can also be acquired once a practitioner is in practice. Regardless of the training pathway, the principles for training are the same:

1. Know the indications, limitations, and contraindications of endoscopic procedures
2. Perform procedures safely, completely, and expeditiously
3. Be able to administer moderate sedation
4. Properly interpret endoscopic findings
5. Identify risk factors and know how to manage complications
6. Understand medical, radiological, and surgical alternative approaches
7. Prepare endoscopy reports and communication with other members of the care team
8. Understand quality measurements and participate in continuous quality improvement

MEDICAL TRAINING IN FLEXIBLE ENDOSCOPY

Training for U.S. internists in GI endoscopy is governed by the American Board of Internal Medicine (ABIM). Gastroenterology is considered a subspecialty of internal medicine, and to become certified in the subspecialty physicians must:

1. Be previously certified in internal medicine by the ABIM
2. Satisfactorily complete the requisite graduate medical education fellowship training
3. Demonstrate clinical competence, procedural skills, and moral and ethical behavior in the clinical setting
4. Hold a valid, unrestricted, and unchallenged license to practice medicine
5. Pass the Gastroenterology Certification Examination

The ABIM mandates that the duration of the fellowship be 36 months with a minimum of 18 months spent on clinical care, and it is expected that graduating fellows can perform diagnostic and therapeutic upper and lower endoscopy.[11]

In addition, gastroenterology fellowship training must be accredited by the Accreditation Council for Graduate Medical Education (ACGME), the Royal College of Physicians and Surgeons of Canada, or the Professional Corporation of Physicians of Quebec. The ACGME states that gastroenterology fellows must demonstrate competence in prevention, evaluation, and management of 19 different disease categories and competence in the performance of 12 procedures (**Table 3.1**).[12] In assessing competence, the ACGME states that the program must assess the fellow in patient management and performance of procedures in both the inpatient and outpatient settings. This assessment must involve direct observation during patient encounters. It is up to each individual program to define criteria for competence for all required and elective procedures. The ACGME also states that the record of evaluation must include the fellow's logbook or an equivalent method to demonstrate that each fellow has achieved competence in the performance of required procedures, but it does not define what constitutes an "equivalent method."

To better define a curriculum that meets the ACGME requirements for knowledge and skill in gastroenterology, four leading U.S. medical societies, the American Association for the Study of Liver Diseases (AASLD), the American College of Gastroenterology (ACG), the American Gastroenterological Association (AGA) Institute, and the American Society for Gastrointestinal Endoscopy (ASGE), created and endorsed the Gastroenterology Core Curriculum.[13] First created in 1996, the curriculum is in its third edition (2007), with a fourth under revision. It is aligned with ACGME requirements for eligibility, training institute requirements, duration, duty hour compliance, and covered disease categories. In addition, it provides details on the scope of knowledge required within each disease category and guidance into the acquisition and verification of technical skill.

The Core Curriculum describes 18 months of clinical training, 3–6 months of research, and an additional 12 months of "elective" time that can be spent focusing on the trainee's interests, including additional clinical training or research. It further defines two levels of training: Level 1 is considered the core clinical requirement and is completed in 18 months. Level 2 is considered "enhanced clinical training" in the areas of geriatric gastroenterology, nutrition, advanced endoscopy (endoscopic retrograde cholangiography and endoscopic ultrasound), motility, hepatobiliary and pancreatic diseases, and hepatology, and is "commonly" completed during an additional 12 months of training beyond the 36 months of fellowship, but could be completed within the 12 months of elective time. The two levels of endoscopic training are for two distinct types of gastroenterologists. Level 1 includes gastroenterologists performing routine GI endoscopic and nonendoscopic procedures as part of the practice of gastroenterology, and gastroenterologists specializing in nonendoscopic aspects of gastroenterology, including, but not limited to, the study of liver

Table 3.1 ACGME required domains of knowledge and skill in gastroenterology training

Diseases	Procedures
• Acid peptic disorders of the GI tract	• Biopsy of the mucosa of the esophagus, stomach, small bowel, and colon
• Acute and chronic gallbladder and biliary tract diseases	• Capsule endoscopy
• Acute and chronic liver diseases	• Colonoscopy with polypectomy
• Acute and chronic pancreatic diseases	• Moderate sedation
• Diseases of the esophagus	• Esophageal dilation
• Disorders of nutrient assimilation	• Esophagogastroduodenoscopy
• Gastrointestinal and hepatic neoplastic disease	• Nonvariceal hemostasis, both upper and lower including actively bleeding patients
• Gastrointestinal bleeding	• Other diagnostic and therapeutic procedures utilizing enteral intubation
• Gastrointestinal diseases with an immune basis	• Paracentesis
• Gastrointestinal emergencies in the acutely ill patient	• Percutaneous endoscopic gastrostomy (PEG)
• Gastrointestinal infections including retroviral, mycotic, and parasitic diseases	• Retrieval of foreign bodies from the esophagus
• Genetic/inherited disorders	• Variceal hemostasis including actively bleeding patients
• Geriatric gastroenterology	
• Inflammatory bowel disease	
• Irritable bowel syndrome	
• Motor disorders of the GI tract	
• Patients under surgical care for GI disorders	
• Vascular disorders of the GI tract	
• Women's health issues in digestive disease	

diseases, motility, nutrition, and basic science research. Level 2 includes gastroenterologists who, in addition to all or part of the above, perform some or all advanced (both diagnostic and therapeutic) GI endoscopy procedures, including ERCP (with sphincterotomy, lithotripsy, stent placement, etc.), endoscopic ultrasound, endoscopic mucosal resection, endoscopic gastroesophageal reflux therapy, and laparoscopy.

When it comes to assessing procedural competence in GI endoscopy, the Core Curriculum states that "Endoscopic competence is difficult to define and quantify. Evaluation remains largely subjective; however, the objective assessment of competence is more desirable." It then goes on to recommend a minimum threshold number of procedures to be completed by a trainee before competency can be assessed (**Table 3.2**). It is further stated that these numbers represent a minimum, and that most trainees require more, but never less, to achieve competency. No references are provided as a basis for the numbers. Procedural Competence Assessment Forms are provided in an appendix of the document for diagnostic upper and lower endoscopy, but no validation science is provided supporting these tools, and no threshold of performance is suggested.

ASGE has also published core curricula for esophagogastroduodenoscopy (EGD) and colonoscopy.[14,15] The EGD curriculum does not discuss assessment. The colonoscopy curriculum recommends using the Mayo Colonoscopy Skills Assessment Tool (MCSAT) throughout training with a goal of achieving a score of 3.5 or higher in all domains. This document also discusses use of quality metrics for practicing gastroenterologists, including cecal intubation rates, polyp detection rates, and appropriate recommendations for patient follow-up. ASGE recognized limitations of the MCSAT including the fact that some of its questions were too broad to be answered accurately and that it could not be used

Table 3.2 ASGE guidelines for endoscopic training in routine procedures: Threshold for assessing competency

Procedure	Required number[a]
Esophagogastroduodenoscopy	130
Including treatment of nonvariceal hemorrhage (10 actively bleeding)	20
Including treatment of variceal hemorrhage (5 actively bleeding)	10
Esophageal dilation (guidewire and through the scope)	20
Colonoscopy	140
Including snare polypectomy and hemostasis	30
Percutaneous endoscopic gastrostomy placement[b]	15
Capsule endoscopy (small bowel)	25

Note: The information in this table represents the current recommendation of the AGSE. Because AGSE guidelines are living documents, they undergo frequent revision. Please check the ASGE website (www.asge.org) to obtain the most current information.

[a] "Required number" represents the threshold number of procedures that must be performed before competency can be assessed. The number represents a minimum, and it is understood that most trainess will require more (never less) than the stated number to meet the competency standards based on existing data.

[b] Refers to the gastric component of the PEG tube placement.

for EGD. As a result, it has developed the Assessment of Competency in Endoscopy (ACE) forms and recommends that these be used for assessment on at least 10% of gastroenterology fellow performed cases.[16] Although ACE was created from modifying the MCSAT—an assessment tool backed by validation science—the ACE form itself has no validity evidence supporting it.

SURGICAL TRAINING IN FLEXIBLE ENDOSCOPY

General surgery

Training programs in general surgery in the United States are governed by the ACGME in a similar fashion to internal medicine and gastroenterology. Individual surgeons are certified in general surgery by the American Board of Surgery (ABS). Flexible GI endoscopy is one of 16 defined categories of procedures that general surgery residents are expected to become competent in during 5 years of clinical training (**Table 3.3**).[17]

Until 2014, a minimum case number of 35 EGDs and 50 colonoscopies served as the clinical basis to assess technical competency. Procedures done as part of surgery (e.g., EGD during Nissen fundoplication; colonoscopy to localize a tumor during colectomy) could not be included in these numbers. The ABS has recognized that flexible endoscopy is an important component of procedures that general surgeons provide for patients and represents a natural extension of MIS. In 2007, 74% of rural surgeons performed more than 50 flexible endoscopic procedures each year, with 42% of rural surgeons performing more than 200 flexible endoscopic procedures annually.[18] In a 2010 report on rural, underserved areas that lack gastroenterology services, 39.8% of an American general surgeons' practice comprises flexible endoscopic procedures.[19] In Canada, surgeons are the primary providers of flexible endoscopic services in smaller urban and rural areas.[20] As a result, the ABS partnered with four surgical societies, the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), the Society for Surgery of the Alimentary Tract (SSAT), the American Society of Colon and Rectal Surgeons (ASCRS), and the American Society of Metabolic and Bariatric Surgery (ASMBS), to create a formal curriculum in flexible endoscopy.[21] The ABS Flexible Endoscopy Curriculum (FEC) is a 5-year distributed curriculum begun in the first year of general surgery residency. It provides a stepwise, milestone-based instructional program for residents to acquire the essential knowledge and skills to perform flexible endoscopy and assesses competence using validated assessment tools. Upon successful completion of the curriculum, a general surgery resident will possess the knowledge and skill to be a surgical endoscopist with the ability to provide endoscopic services to patients in any clinical setting. A *surgical endoscopist* is a surgeon who has the knowledge and technical skill to use flexible endoscopy to provide care for patients with common GI diseases. This ability includes the following:

1. An understanding of the indications and contraindications for performing upper and lower endoscopy
2. Accurate recognition and management of normal and abnormal findings in the GI tract

Table 3.3 Minimum case numbers for general surgery residents for the academic year 2017–2018

Category	Minimum
Skin, Soft tissue	**25**
Breast	**40**
Mastectomy	5
Axilla	5
Head and neck	**25**
Alimentary tract	**180**
Esophagus	5
Stomach	15
Small intestine	25
Large intestine	40
Appendix	40
Anorectal	20
Abdominal	**250**
Biliary	85
Hernia	85
Liver	5
Pancreas	5
Vascular	**50**
Access	10
Anastomosis, repair, or endarterectomy	10
Endocrine	**15**
Thyroid or parathyroid	10
Operative trauma	**10**
Nonoperative trauma	**40**
Resuscitations as team leader	10
Thoracic surgery	**20**
Thoracotomy	5
Pediatric surgery	**20**
Plastic surgery	**10**
Surgical critical care	**40**
Laparoscopic basic	**100**
Endoscopy	**85**
Upper endoscopy	35
Colonoscopy	50
Laparoscopic complex	**75**
Total major cases	**850**
Chief year major cases	200
Teaching assistant cases	25

Source: Defined Category Minimum Numbers: General Surgery Effective for Program Graduates Beginning Academic Year 2017–2018. ©2017 Accreditation Council for Graduate Medical Education (ACGME).

Note: Case logs for residents graduating in 2018 will be assessed using these new minimums beginning with the 2019 ACGME Annual Program Review.

3. Recognition and management of complications from performing GI endoscopy
4. Safe performance of upper and lower endoscopy, including complete navigation of the esophagus, stomach, proximal duodenum, and colon
5. Mucosal inspection and recognition of lesions that may require surgery
6. Tissue acquisition using biopsy or polypectomy
7. Management of periprocedural bleeding
8. Placement of a percutaneous endoscopic gastrostomy

The ABS-FEC contains five levels. Each level defines cognitive and technical milestones to be achieved and recommended resources to use. Didactic material supporting the FEC includes the Surgical Council on Resident Education (SCORE) Portal—a program containing high-quality educational materials and a structured program for self-learning in all areas of general surgery—and the Fundamentals of Endoscopic Surgery (FES) web modules.[22,23] Technical training comes from work on physical or computer simulators and clinical cases performed both inside and outside of the operating room. The ABS-FEC also uses a validated clinical assessment tool for measuring the performance of upper and lower endoscopy (the Global Assessment of Gastrointestinal Endoscopic Skills [GAGES]) and a high-stakes test of knowledge and skill through the FES program.

GAGES is a global assessment form used to evaluate performance in upper and lower endoscopy.[24] Each form (GAGES-UE; GAGES-C) assesses five domains on a Likert scale of 1–5 with strong anchors at 1, 3, and 5. A maximum score of 25 is possible. Multi-institutional testing has shown excellent performance by the GAGES tool to separate novice from expert performance. It is also easy to administer, consistent, and meets high standards for reliability and validity. Reliably achieving GAGES scores of 18 or higher for both upper and lower endoscopy is required for successful completion of the ABS-FEC.

The FES is a high-stakes test of knowledge and skill in flexible GI endoscopy. It consists of three components. The first is web-based didactic material covering the knowledge required to safely and effectively use endoscopy in practice. The second is a multiple choice exam administered in a secure testing environment at an approved testing center. The third is a test of technical skill using a computer-based simulator also administered at an approved testing center. Validation studies support the use of FES as a high-stakes exam, and passage of the exam is required before a general surgery resident can take the ABS qualifying exam—the first step toward board certification.[25,26]

Now that the ABS-FEC has been implemented, beginning in July 2018, every graduating general surgery resident in the United States will have been required to successfully complete a 5-year distributed curriculum in flexible GI endoscopy that includes minimum case numbers, requisite didactic material review and skills rehearsal, validated assessment of clinical performance, and a high-stakes exam. This will serve as the basis for taking the ABS qualifying exam. If successfully completed, the candidate will then take the ABS certifying exam; an oral exam with six expert examiners who are required to pose a minimum number of questions in the domain of flexible endoscopy.

Colon and rectal surgery

Colon and rectal surgery (CRS) is the specialty that focuses on the medical, surgical, endoscopic, and perioperative management of disorders involving the colon, rectum, and anus, and related problems of the abdomen, pelvis, and perineum. Training programs providing training in CRS are governed by the ACGME.[27] Entry into training requires successful completion of an ACGME or Royal College of Physicians and Surgeons of Canada (RCPSC)–accredited residency program in surgery of not less than 5 years of progressive education, and to be certified by the American Board of Surgery (ABS) or have completed the educational requirements to sit for the ABS qualifying examination. Training duration is 12 months beyond general surgery residency. Graduates must "demonstrate a high level of skill and dexterity in the performance of all essential colon and rectal surgical procedures." Endoscopy, including anoscopy, diagnostic and therapeutic colonoscopy, and rigid and flexible sigmoidoscopy are considered essential. Minimum case numbers are suggested by the ACGME (140 colonoscopies, 30 with intervention beyond biopsy), but they are not required for board certification by the American Board of Colon and Rectal Surgeons.[28,29]

Fellowship Council flexible endoscopy fellowship

The Fellowship Council (FC) is an organization created to foster the development of high-quality non-ACGME-approved fellowships in MIS, GI surgery, flexible endoscopy, bariatric and metabolic surgery, noncardiac thoracic surgery, advanced colon and rectal surgery, and hepato-pancreato-biliary (HPB) surgery through a program accreditation pathway and universal application and matching process.[30] A FC flexible endoscopic fellowship focuses on the treatment of patients and diseases that require advanced endoscopic techniques. The fellowship provides experience in advanced upper and lower endoscopic procedures and focuses on therapeutic endoscopy.

The FC defines a suggested curriculum for its flexible endoscopy fellowships.[31] While case numbers for individual procedures are not required, a minimum of 100 therapeutic endoscopic procedures must be performed annually by the fellow to be accredited as a FC Flexible Endoscopy fellowship. Except for ERCP, no metrics of performance are suggested for the FC curriculum.

Table 3.4 summarizes the requirements for medical and surgical training in flexible GI endoscopy.

Table 3.4 Requirements for medical and surgical training in flexible GI endoscopy

	GI fellowship	General surgery residency	Colon and rectal surgery residency	Fellowship Council flexible endoscopy fellowship
Minimum case volume	√[a]	√		√
Written knowledge test[b]		√		√[c]
Oral knowledge test		√		√
Validated assessment of clinical performance		√		√
Case log		√	√	√
Duration of training (months)	18	60	12	12

[a] No case log required.
[b] Specific to performance of flexible endoscopy and separate from Board exams.
[c] FES certification required.

TRAINING WHILE IN PRACTICE

Once a physician has completed formal residency and fellowship training, it can be difficult to learn how to perform flexible endoscopy while in practice. A significant barrier is the legal and regulatory requirements for a practicing clinician to participate in hands-on clinical cases. In an effort to overcome this obstacle, some professional societies have partnered with world-class international institutes to provide this hands-on experience.

The European Society of Gastrointestinal Endoscopy (ESGE) offers two levels of training for practicing physicians. Module I is entitled "Basic Training with Experts" and provides training on basic steps and specific techniques. A maximum of 4 weeks of training is foreseen, and hands-on clinical training is not provided. Module II, entitled "Advanced Training with Experts," lasts from 3 to 6 months depending on the number of procedures involved and on the field of expertise of the host training center. Learners get hands-on training on specific techniques during this period. Fourteen international centers participate in Module II training.[32]

The SAGES has been piloting a novel program for practicing surgeons. It combines online didactic material review with 3 days of stateside laboratory skills and case observation. Participants then travel to a world-class institute in Asia to participate in a high volume of clinical procedures. Surgeons participating in this program are required to be FES certified and will perform nearly 300 procedures over 2 weeks. Clinical performance is assessed using GAGES.

PRIVILEGING IN FLEXIBLE GI ENDOSCOPY

Credentialing represents the verification of a person's education, training, and experience. Privileging gives permission for a person to engage in specific clinical activities. Current credentialing and privileging structure in the United States requires that each health-care facility manage the process. This leaves many facilities looking for guidance on how to grant privileges to clinicians who wish to perform flexible endoscopic procedures. Both medical and surgical professional societies have created guidelines to help in these decisions. However, the guidelines often differ significantly in their recommendations. Two of the leading societies in this space are SAGES and ASGE.

In 2016, SAGES published updated guidelines for privileging and credentialing in GI endoscopy.[33] This guideline put forth a number of recommendations for granting privileges. The first is to apply a uniform standard to all physicians requesting privileges to perform endoscopy and that these standards use evidenced-based criteria. The goal is to grant privileges to all physicians with proper training and experience so as to ensure the delivery of high-quality and safe patient care.

Another recommendation is the requirement that all physicians privileged in endoscopy have completed a program that includes formal training in endoscopy. This program could be a general surgery residency, gastroenterology fellowship, colon and rectal surgery residency, or a mini-fellowship (for those who sought training outside of a formal residency program), as long as the fellowship fulfills the requirements for minimal case volumes, knowledge of GI diseases, objective assessment of performance, and certification of proficiency by a qualified endoscopist.

SAGES also states that, while efficiency in endoscopy increases with increasing experience, quality measures in endoscopy and complication rates are not related to specialty or case volumes. As a result, objective assessment of procedural competence using validated tools should be used rather than case numbers alone. The guidelines also state that completion of a comprehensive endoscopy curriculum, which includes use of validated assessment tools, may make one eligible for initial privileging for endoscopy, but that assessment of skills and outcomes after granting privileges should be intensive, individualized, and ongoing. They suggest using a Focused Professional Practice Evaluation (FPPE) to evaluate endoscopic skills, assess quality metrics, and follow patient outcomes. They also recommend periodic Ongoing Professional Practice Evaluations (OPPEs). FPPEs and OPPEs have long been used in surgery for ensuring competence in other surgical procedures.

Finally, SAGES recommends that renewal and maintenance of privileges should include assessment of quality metrics and participation in quality improvement measures.

Figure 3.1 outlines SAGES' suggested checklist for initial privileging in GI endoscopy.

In 2017, ASGE published their guidelines for privileging, credentialing, and proctoring to perform GI endoscopy.[34] The authors state that, whenever possible, competence should be determined based on objective criteria and direct observation. Performance of an arbitrary number of procedures does not guarantee competency because of differences in individual learning curves. ASGE then goes on, however, to state that minimum threshold numbers may be set, below which competency cannot be assessed, and they provide their opinion on what these numbers should be for 14 different procedures.

Multiple societies have criticized the ASGE document in writing. They highlight the inherent problem of utilizing procedural numbers as a surrogate for measuring technical skill, the importance of quality training, and point out a number of methodological issues with the ASGE guideline. To begin with, procedural numbers are an inadequate measure of competence. Individual learning curves of technical skills vary based on natural talent, dedicated and deliberate practice time, and educational exposure of learners to procedures.[35] Competency is better attained when training goals are set for learners and training is tailored to individual needs. Goal-oriented training ensures that competence is acquired uniformly

1. Evidence of adequate training

_______ *Completion of ACGME accredited residency program in general surgery, fellowship in colorectal surgery, pediatric surgery, or gastroenterology.*

OR

_______ *Completion of training program with experience equivalent to one of the above.*

OR

_______ *Completion of an intense immersion training program with a robust curriculum that achieves endoscopic competence equivalent to one of the above.*

2. Evidence of technical skill

_______ *Acknowledgment and attestation of skill level by current or past department chief or supervising physicians*

AND

_______ *Successful performance scores on a validated assessment tool of endoscopic skill*

3. Participation in an ongoing quality assessment program

_______ *Track the following metrics for colonoscopy*

- *Quality assessment cecal intubation rate*
- *Adenoma detection rate*
- *Complications (perforation, bleeding, sedation complications).*
- *Follow up recommendations*

AND

_______ *Perform FPPE and OPPE per institution guidelines for both upper and lower endoscopy*

AND

_______ *Participation in an ongoing quality assessment program*

AND

_______ *Periodic OPPE*

AND

_______ *FPPE for recognized deficiencies*

Figure 3.1 SAGES suggested checklist for initial privileging in GI endoscopy.

by learners, independent of numbers of procedures required by each trainee.[36] The superiority of goal-oriented over number-based training has been shown by experts in the field.[37,38]

There are also methodologic issues with the ASGE guideline. First, the results of their systematic review are not provided, making it hard to verify the accuracy of the work. Second, the overall quality of the available evidence and number of published studies is extremely limited to draw meaningful conclusions, let alone define robust procedural thresholds for competency and certification. Third, the ASGE guidelines apply inconsistent criteria when defining minimum threshold numbers. They use the highest reported number according to their systematic review for colonoscopy ($n = 275$, range 75–280), a higher number for ERCP ($n = 200$, range 70–185), and an intermediate number for EUS ($n = 225$, range 78 to >400). In addition, numbers recommended for more complex procedures, like endoscopic mucosal resection ($n = 20$) or endoscopic submucosal dissection ($n = 30$), are small compared to numbers listed for EGD ($n = 130$) and colonoscopy.

Based on this information, multiple societies have recommended that the numbers proposed in the ASGE document not be used for granting privileges for GI endoscopy.

CONCLUSIONS

Both surgeons and gastroenterologists play an important role in providing endoscopic services to patients. Both specialties have created credible training pathways that lead to competence in performing flexible endoscopy. Privileging for these procedures should recognize these pathways and be based on uniform standards that do not rely on procedure numbers alone, but include valid assessments of knowledge and skill. After the granting of initial privileges, maintenance and renewal of privileges should be based on assessments of quality and participation in quality improvement measures.

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4

Anesthetic challenges in the gastrointestinal suites

SHEILA RYAN BARNETT

INTRODUCTION

The number and types of cases performed in the gastrointestinal suites settings are exploding. With advances in therapeutic technology, common gastrointestinal conditions that in the past may have required an open surgery are now often amenable to noninvasive procedures.[1,2] At the same time, the demand for noninvasive diagnostic studies using an endoscopic ultrasound and other modalities has led to a significant increase in the volume of cases. These complex procedures frequently require a deep level of sedation or anesthesia.[3,4] To accommodate the increased demand, many suites are now frequently equipped to allow the delivery of deep sedation and even general anesthesia in addition to traditional nurse-administered moderate sedation.[4]

An understanding of the different sedation and anesthesia options available is important when choosing the type of sedation or anesthesia for these cases. Appropriate choices can improve patient and provider outcomes, including satisfaction.[5] This chapter highlights the differences between anesthesia options, common medications administered, and potential hazards of sedation during some of the more common procedures encountered.

WHAT TYPES OF SEDATION AND ANESTHESIA ARE AVAILABLE?

The American Society of Anesthesiologists describes four levels of sedation—minimal, moderate, deep, and general anesthesia (**Table 4.1**).[6] Most simple endoscopy cases are performed with either nurse-administered moderate sedation or using deep sedation with propofol with an anesthesia provider, referred to as Monitored Anesthesia Care (MAC). Less commonly, a patient may require a general anesthesia and endotracheal intubation, usually in cases that are painful, are prolonged, or carry a significant risk of aspiration, hypoventilation, or general hemodynamic instability. The type of sedation and anesthesia required for an endoscopy case depends on the patient, both expectations and comorbid conditions, and the invasiveness of the procedure.[7] Certain patient conditions increase the difficulty of administering sedation; for example, a history of opioid tolerance, alcohol, and regular illicit drug use can increase the patient's tolerance to common sedatives such as benzodiazepines and opioids (**Table 4.2**). These patients will be challenging to sedate without very large doses of medications and

Table 4.1 American Society of Anesthesiologists level of sedation

	Minimal sedation	Moderate sedation	Deep sedation	General anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal and tactile stimulation	Purposeful response following repeated or painful stimulation	Unarousable, even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular function	Unaffected	Usually maintained	Usually maintained	May be impaired

Source: American Society of Anesthesiologists Task Force on Sedation and Analgesia by Non-Anesthesiologists. *Anesthesiology* 2002;96(4):1004–17.