

The SAGES Manual of Evolving Techniques in Pancreatic Surgery

Eugene P. Ceppa • Kevin M. El-Hayek
Melissa E. Hogg • Nicolò Pecorelli
Editors

The SAGES Manual of Evolving Techniques in Pancreatic Surgery

 Springer

Editors

Eugene P. Ceppa
Department of Surgery
Indiana University School of Medicine
Indianapolis, IN, USA

Melissa E. Hogg
NorthShore University HealthSystem
Evanston, IL, USA

Kevin M. El-Hayek
Division of General Surgery,
The MetroHealth System, Case Western
Reserve University School of Medicine
Cleveland, OH, USA

Nicolò Pecorelli
Pancreas Translational & Clinical
Research Center
San Raffaele Scientific Institute, Vita-Salute
San Raffaele University
Milano, Italy

ISBN 978-3-031-78408-8 ISBN 978-3-031-78409-5 (eBook)
<https://doi.org/10.1007/978-3-031-78409-5>

© Society of American Gastrointestinal 2025

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

If disposing of this product, please recycle the paper.

Eugene P. Ceppa

I dedicate this to VXC, CLC, GDC, and DPC for their continued unwavering love, support, and patience. To IMC and PRC, I thank you for the love, guidance, and persistence to accomplish one's goals. I give thanks to my mentors along the way including Bertrand Garcia-Moreno, Gregory Bulkley, Keith Lillemoe, Ted Pappas, Paul Kuo, Kimberly Kirkwood, Bryan Clary, Rory Pryor, and Henry Pitt. With great admiration, I thank Kevin, Melissa, Nicolò, and Monia for their tireless effort, collegial collaboration, and making this experience feel more like a family and not just colleagues.

Kevin M. El-Hayek

To my mother and father, Annette and Salim El-Hayek for supporting my academic journey from day one. To my wife Raechel and my children, Keira, Alison, and Cameron for being supportive when my work extends into nights and weekends. I'd also like to dedicate this book to my mentors in hepatopancreato-biliary surgery, namely,

R. Matthew Walsh, Sricharan Chalikonda, and J. Michael Henderson. Without your knowledge, experience, and willingness to share, I would not be the HPB surgeon I am today—I am eternally grateful. To the SAGES HPB leaders who supported my progress in the field of MIS HPB surgery, Horacio Asbun and Adnan Alseidi. And of course, this book would not be possible without the SAGES HPB/Solid Organ committee members (the BEST committee!) and the glue that keeps us together, Monia Ilunga.

Melissa E. Hogg

To young, old, current, and future pancreas surgeons as well as authors and editors of this manual. Continue to learn, evolve, and work hard to take care of sick patients.

Nicolò Pecorelli

To my mother Antonella, who was my number 1 supporter and would have loved to own a copy of this book. To my wife Ilaria and my kids Olivia, Arturo, and Lavinia—you are my everyday joy. To my father Sergio for inspiring my passion for research. Also, to my friend Jody for reminding me to stay hungry for science. I'd also like to dedicate this book to my first mentors in pancreatic surgery, Profs. Valerio Di Carlo, Marco Braga, and Gianpaolo Balzano, who taught me that surgery is not only a matter of hands, but also reason and soul. To my co-editors Melissa, Kevin, Eugene, and the SAGES HPB/Solid Organ committee friends who worked so hard to make this book happen.

Disclaimer

Disclaimer for Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Manual: The contents of this manual are intended exclusively for educational and informational purposes only, and nothing contained within constitutes medical advice. Neither this manual nor its contents have been subject to formal peer review. The information provided herein does not represent, nor should it be interpreted as, the official position, view, or endorsement of the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) or its governing body. This manual is not intended for use in diagnosing or treating any health problem, condition, or disease. Individuals seeking personal medical advice should consult an appropriate licensed professional.

Neither SAGES, nor its officers, directors, employees, members, nor any of the contributors to this manual make any representation or warranty, express or implied, regarding the accuracy, completeness, fitness for any intended purpose, or suitability of the information contained herein for any specific use or function. Neither access to nor use of this manual creates or implies any physician-patient relationship, and reliance on any information provided, contained, or implied herein is solely at the user's own risk.

Contents

Part I Anatomy and Physiology

- 1 Anatomy and Physiology** 3
Jessica Heard, Malynn Anne Ilanga, and Edward Cho

Part II Acute Pancreatitis

- 2 Diagnosis and Medical Management of Acute Pancreatitis** 19
Carlos Theodore Huerta, Jodie Adam Barkin, and Onur C. Kutlu
- 3 Acute Pancreatitis: Non-surgical Therapies Including Gallstone Management** 39
Anne Nagelhout, Martijn W. J. Stommel, Stefan A. W. Bouwense, Marc G. Besselink, and for the Dutch Pancreatitis Study Group
- 4 Acute Pancreatitis: Surgical Therapies** 51
Osaid Alser, Kanak Das, and Edwin Onkendi
- 5 Acute Pancreatitis: Complications** 87
Jackson A. Baril, Rachel C. Kim, and Eugene P. Ceppa

Part III Chronic Pancreatitis

- 6 SAGES Manual: Chronic Pancreatitis—Classification and Medical Management** 99
Emily Hensler and Subhashini Ayloo
- 7 Chronic Pancreatitis: Drainage Procedures (Open Vs. MIS)** 115
Dhiresh Rohan Jeyarajah and Houssam G. Osman
- 8 Chronic Pancreatitis: Resection** 125
Jonathan C. DeLong and Brendan C. Visser
- 9 Combined Procedures (Open Vs. MIS)** 141
Jörg Kleeff, Johannes Klose, and Ulrich Ronellenfitsch

10	Total Pancreatectomy with Islet Cell Autotransplantation	157
	Jenny Chang, Robert Simon, and R. Matthew Walsh	
Part IV Preoperative Diagnosis and Surgical Indications		
11	Benign, Premalignant, and Malignant Duodenal Neoplasms	173
	Matthew Hernandez, Paul Wong, and Laleh Melstrom	
12	Endoscopic Duodenal Resection	189
	Catherine Vozzo and Ashley Faulx	
13	Surgical: Transduodenal Resection (Open vs Minimally Invasive) . . .	203
	Ann Polcari, Aram Rojas, and Melissa E. Hogg	
14	Segmental Duodenectomy	231
	Domenech Asbun, John Stauffer, and Horacio J. Asbun	
15	Cystic Neoplasms	249
	G. Corvino, G. Perri, R. Salvia, and G. Marchegiani	
16	Pancreatic Ductal Adenocarcinoma	275
	Ricardo J. Bello and Callisia N. Clarke	
17	Pancreatic Neuroendocrine Neoplasms	295
	Allen A. Razavi, Jaewon Lee, and Alexandra Gangi	
18	Secondary Malignant Neoplasms	311
	Ross Mudgway, Daniel J. Oliveira, and David Caba Molina	
Part V Surgical Technique—Pancreatoduodenectomy		
19	Open Whipple	329
	Rachel C. Kim, Jackson A. Baril, and Trang K. Nguyen	
20	Laparoscopic Pancreatoduodenectomy	343
	Núria Lluís, Domenech Asbun, and Horacio J. Asbun	
21	Robotic Pancreatoduodenectomy	369
	Sharona Ross, Harel Jacoby, Cameron Syblis, Iswanto Sucandy, and Alexander Rosemurgy	
Part VI Surgical Technique—Distal Pancreatectomy		
22	Open Distal Pancreatectomy	393
	Andrew J. Sinnamon and Pamela J. Hodul	
23	Laparoscopic Distal Pancreatectomy	405
	Elena Panettieri, Eduardo A. Vega, Ariana Chirban, and Claudius Conrad	

24	Robotic-Assisted Approach to Minimally Invasive Distal Pancreatectomy	419
	Chelsea F. Cardell and Gerard J. Abood	
25	Spleen-Preserving Distal Pancreatectomy	431
	Jane Wang, Camilla Gomes, Zaim Chaudhary, and Adnan Alseidi	
26	Minimally Invasive Distal Pancreatectomy with Celiac Artery Resection	441
	Gilbert Murimwa and Patricio M. Polanco	
27	Enucleation	459
	Luca Milone, Mei Zhen Cao, Andrew Gumbs, and Romulo Genato	
28	Minimally Invasive Central Pancreatectomy	471
	Vincent Butano, Iswanto Sucandy, Sharona Ross, and Alexander Rosemurgy	
29	Palliation of Pancreatic Cancer	485
	Imad Elkhatib and Marc Mesleh	
 Part VII Perioperative Considerations—Perioperative Management		
30	Preoperative Risk Stratification to Prehabilitation	507
	Maximiliano Servin-Rojas and Motaz Qadan	
31	Enhanced Recovery Pathways: What’s the Evidence?	523
	Didier Roulin, David Martin, and Nicolas Demartines	
32	Perioperative Nutrition in Pancreatic Surgery	543
	Alessia Vallorani, Martina Abati, Chiara Limongi, and Nicolò Pecorelli	
 Part VIII Postoperative Complications		
33	Short-Term Morbidity After Pancreatectomy	565
	Heather E. Matheny and Amir H. Fathi	
34	Prevention, Prediction, and Mitigation of Pancreatic Fistula	591
	Fabio Casciani, Maxwell T. Trudeau, and Charles M. Vollmer	
35	Post-Pancreatectomy Hemorrhage	609
	Joshua P. Kronenfeld and Onur C. Kutlu	
36	Delayed Gastric Emptying	619
	Szu-Aun Long and Rebecca A. Snyder	
37	Long-Term Sequelae: Pancreatic Exocrine and Endocrine Failure	639
	Nicholas Caminiti and Robert Martin	

38 How to Measure Postoperative Outcomes 645
Elizabeth L. Barbera, Alexandra M. Adams,
and Timothy J. Vreeland

39 SAGES University Master’s Program: Pancreas Pathway 657
Hemasat Alkhatib, Voranaddha Vacharathit, and Kevin M. El-Hayek

Index 673

Contributors

Martina Abati Division of Pancreatic Surgery, Pancreas Translational and Clinical Research Center, San Raffaele Scientific Institute, Milan, Italy
Nutrition Service, San Raffaele Scientific Institute, Milan, Italy

Gerard J. Abood Department of Surgery, Loyola University Medical Center, Maywood, IL, USA

Alexandra M. Adams Brooke Army Medical Center, Fort Sam Houston, TX, USA

Hemasat Alkhatib Division of General Surgery, MetroHealth System, Cleveland, OH, USA

Adnan Alseidi Department of Surgery, University of California, San Francisco, San Francisco, CA, USA

Osaid Alser Texas Tech University Health Sciences Center, Lubbock, TX, USA

Domenech Asbun Division of Hepatobiliary and Pancreas Surgery, Miami Cancer Institute, Miami, FL, USA

Horacio J. Asbun Division of Hepatobiliary and Pancreas Surgery, Miami Cancer Institute, Miami, FL, USA

Subhashini Ayloo Department of Surgery, Warren Alpert Medical School of Brown University, Providence, RI, USA

Elizabeth L. Barbera Brooke Army Medical Center, Fort Sam Houston, TX, USA

Jackson A. Baril Department of Surgery, Indiana University School of Medicine, Indianapolis, IN, USA

Jodie Adam Barkin Pancreas Center, Division of Gastroenterology, University of Miami Miller School of Medicine, Miami, FL, USA

Ricardo J. Bello Division of Surgical Oncology, Medical College of Wisconsin, Milwaukee, WI, USA

Marc G. Besselink Department of Surgery, Amsterdam UMC, Location University of Amsterdam, Amsterdam, The Netherlands
Amsterdam Gastroenterology Endocrinology Metabolism, Amsterdam, The Netherlands

Stefan A. W. Bouwense Department of Surgery, Maastricht University Medical Centre+, Maastricht, The Netherlands

Vincent Butano Digestive Health Institute at AdventHealth, Tampa, FL, USA

Nicholas Caminiti Department of Surgery, University of Louisville, Louisville, KY, USA

Mei Zhen Cao Department of General Surgery, The Brooklyn Hospital Center, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Chelsea F. Cardell Department of Surgery, Loyola University Medical Center, Maywood, IL, USA

Fabio Casciani University of Verona, Verona, Italy
University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

Eugene P. Ceppa Department of Surgery, Indiana University School of Medicine, Indianapolis, IN, USA

Jenny Chang Department of General Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH, USA

Zaim Chaudhary University of California, Berkeley, Berkeley, CA, USA

Ariana Chirban Department of Surgery, St. Elizabeth's Medical Center, Boston University School of Medicine, Boston, MA, USA
University of California, San Diego, School of Medicine, La Jolla, CA, USA

Edward Cho Department of Surgery, University of Oklahoma at Tulsa, Tulsa, OK, USA
Department of Surgery, University of Illinois Peoria, Peoria, IL, USA

Callisia N. Clarke Division of Surgical Oncology, Medical College of Wisconsin, Milwaukee, WI, USA

Claudius Conrad Department of Surgery, St. Elizabeth's Medical Center, Boston University School of Medicine, Boston, MA, USA
Carle Cancer Institute, Carle Illinois College of Medicine, Urbana, IL, USA

G. Corvino Department of General and Pancreatic Surgery, The Pancreas Institute Verona, University of Verona Hospital Trust, Verona, Italy

Kanak Das Texas Tech University Health Sciences Center, Lubbock, TX, USA

Jonathan C. DeLong Division of Surgical Oncology, University of Tennessee Medical Center Knoxville, Knoxville, TN, USA

Nicolas Demartines Department of Visceral Surgery, Lausanne University Hospital CHUV, University of Lausanne, Lausanne, Switzerland

Kevin M. El-Hayek Division of General Surgery, MetroHealth System, Cleveland, OH, USA

Case Western Reserve University School of Medicine, Cleveland, OH, USA
Northeast Ohio Medical University, Rootstown, OH, USA

Imad Elkhatib Advanced/Therapeutic Endoscopy, Advocate Christ Medical Center, Oak Lawn, IL, USA

Amir H. Fathi University of California San Francisco, Fresno MEP, Fresno, CA, USA

Ashley Faulx Division of Gastroenterology, University Hospitals of Cleveland, Case Western Reserve University School of Medicine, Cleveland, OH, USA

Alexandra Gangi Department of Surgical Oncology, Cedars-Sinai Medical Center, Los Angeles, CA, USA

Romulo Genato Department of General Surgery, The Brooklyn Hospital Center, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Camilla Gomes Department of Surgery, University of California, San Francisco, San Francisco, CA, USA

Andrew Gumbs Department of General Surgery, The Brooklyn Hospital Center, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Jessica Heard Department of Surgery, University of Oklahoma at Tulsa, Tulsa, OK, USA

Emily Hensler Department of Surgery, Warren Alpert Medical School of Brown University, Providence, RI, USA

Matthew Hernandez Department of Surgery, City of Hope National Medical Center, Duarte, CA, USA

Pamela J. Hodul Moffitt Cancer Center, Tampa, FL, USA

Melissa E. Hogg NorthShore University HealthSystem, Evanston, IL, USA

Carlos Theodore Huerta DeWitt Daughtry Family Department of Surgery, University of Miami Miller School of Medicine, Miami, FL, USA

Malynn Anne Ilanga Department of Surgery, University of Oklahoma at Tulsa, Tulsa, OK, USA

Harel Jacoby Advent Health Tampa Digestive Health Institute, Tampa, FL, USA
Sheba Medical Center, Tel-Aviv, Israel

Dhiresh Rohan Jeyarajah Department of Surgery, Methodist Health System, Dallas, TX, USA

Department of Surgery, TCU Burnett School of Medicine, Fort Worth, USA

Rachel C. Kim Department of Surgery, Indiana University School of Medicine, Indianapolis, IN, USA

Jörg Kleeff Department of Visceral, Vascular and Endocrine Surgery, University Hospital Halle (Saale), Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany

Johannes Klose Department of Visceral, Vascular and Endocrine Surgery, University Hospital Halle (Saale), Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany

Joshua P. Kronenfeld DeWitt Daughtry Department of Surgery, University of Miami Miller School of Medicine, Miami, FL, USA

Onur C. Kutlu DeWitt Daughtry Department of Surgery, University of Miami Miller School of Medicine, Miami, FL, USA

Jaewon Lee Department of Surgical Oncology, Cedars-Sinai Medical Center, Los Angeles, CA, USA

Chiara Limongi Vita-Salute San Raffaele University, Milan, Italy

Núria Lluís Division of Hepatobiliary and Pancreas Surgery, Miami Cancer Institute, Miami, FL, USA

Szu-Aun Long Department of Surgery, University of Cincinnati College of Medicine, Cincinnati, OH, USA

G. Marchegiani Hepatopancreatobiliary and Liver Transplant Surgery, Department of Surgery, Oncology and Gastroenterology (DiSCOG), University of Padua, Padua, Italy

David Martin Department of Visceral Surgery, Lausanne University Hospital CHUV, University of Lausanne, Lausanne, Switzerland

Robert Martin Department of Surgery, University of Louisville, Louisville, KY, USA

Heather E. Matheny Vascular Surgery, University of Washington, Seattle, WA, USA

Laleh Melstrom Department of Surgery, City of Hope National Medical Center, Duarte, CA, USA

Marc Mesleh Department of Surgery, University of Illinois Chicago (UIC), Chicago, IL, USA
Advocate Christ Medical Center, Oak Lawn, IL, USA

Luca Milone Division of Robotic Surgery, Department of General Surgery, The Brooklyn Hospital Center, Icahn School of Medicine at Mount Sinai, New York, NY, USA

David Caba Molina Loma Linda University, Loma Linda, CA, USA
Riverside University Health System/University of California-Riverside, Loma Linda, CA, USA

Ross Mudgway Loma Linda University, Loma Linda, CA, USA

Gilbert Murimwa Department of Surgery, University of Texas Southwestern Medical Center, Dallas, TX, USA

Anne Nagelhout Department of Surgery, Radboudumc, Nijmegen, The Netherlands
Department of Research and Development, St. Antonius Hospital, Nieuwegein, The Netherlands

Trang K. Nguyen Division of Surgical Oncology, Washington University in St. Louis, St. Louis, MO, USA

Daniel J. Oliveira Loma Linda University, Loma Linda, CA, USA

Edwin Onkendi Texas Tech University Health Sciences Center, Lubbock, TX, USA

Houssam G. Osman Department of Surgery, Methodist Health System, Dallas, TX, USA

Elena Panettieri Department of Surgery, St. Elizabeth's Medical Center, Boston University School of Medicine, Boston, MA, USA
Hepatobiliary Surgery, Fondazione "Policlinico Universitario A. Gemelli", IRCCS, Università Cattolica del Sacro Cuore, Rome, Italy

Nicolò Pecorelli Vita-Salute San Raffaele University, Milan, Italy
Division of Pancreatic Surgery, Pancreas Translational and Clinical Research Center, San Raffaele Scientific Institute, Milan, Italy
Pancreas Translational & Clinical Research Center, San Raffaele Scientific Institute, Vita-Salute San Raffaele University, Milan, Italy

G. Perri Hepatopancreatobiliary and Liver Transplant Surgery, Department of Surgery, Oncology and Gastroenterology (DiSCOG), University of Padua, Padua, Italy

Patricio M. Polanco Division of Surgical Oncology, Department of Surgery, University of Texas Southwestern Medical Center, Dallas, TX, USA

Ann Polcari University of Chicago, Chicago, IL, USA

Motaz Qadan Division of Surgical Oncology, Department of Surgery, Massachusetts General Hospital, Boston, MA, USA

Allen A. Razavi Department of Surgical Oncology, Cedars-Sinai Medical Center, Los Angeles, CA, USA

Aram Rojas NorthShore University HealthSystem, Evanston, IL, USA

Ulrich Ronellenfitsch Department of Visceral, Vascular and Endocrine Surgery, University Hospital Halle (Saale), Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany

Alexander Rosemurgy Department of Surgery, University of Central Florida, Orlando, FL, USA

Advent Health Tampal Digestive Health Institute, Tampa, FL, USA

Department of Surgery, Nova Southeastern University, Fort Lauderdale, FL, USA

Sharona Ross Department of Surgery, University of Central Florida, Orlando, FL, USA

Advent Health Tampal Digestive Health Institute, Tampa, FL, USA

Department of Surgery, Nova Southeastern University, Fort Lauderdale, FL, USA

Didier Roulin Department of Visceral Surgery, Lausanne University Hospital CHUV, University of Lausanne, Lausanne, Switzerland

R. Salvia Department of General and Pancreatic Surgery, The Pancreas Institute Verona, University of Verona Hospital Trust, Verona, Italy

Maximiliano Servin-Rojas Department of Surgery, Massachusetts General Hospital, Boston, MA, USA

Robert Simon Department of General Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH, USA

Andrew J. Sinnamon Moffitt Cancer Center, Tampa, FL, USA

Rebecca A. Snyder Department of Surgical Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

John Stauffer Department of Surgery, Mayo Clinic Florida, Jacksonville, FL, USA

Martijn W. J. Stommel Department of Surgery, Radboudumc, Nijmegen, The Netherlands

Iswanto Sucandy Department of Surgery, University of Central Florida, Orlando, FL, USA

Advent Health Tampal Digestive Health Institute, Tampa, FL, USA

Cameron Syblis University of South Florida Morsani College of Medicine, Tampa, FL, USA

Advent Health Tampal Digestive Health Institute, Tampa, FL, USA

Maxwell T. Trudeau University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

University of Connecticut School of Medicine, Farmington, CT, USA

Voranaddha Vacharithit Faculty of Medicine, Department of Surgery, Chulalongkorn University, Bangkok, Thailand

King Chulalongkorn Memorial Hospital, The Thai Red Cross Society, Bangkok, Thailand

Alessia Vallorani Vita-Salute San Raffaele University, Milan, Italy

Eduardo A. Vega Department of Surgery, St. Elizabeth's Medical Center, Boston University School of Medicine, Boston, MA, USA

Brendan C. Visser Division of Hepatobiliary and Pancreas Surgery, Stanford University, Stanford, CA, USA

Charles M. Vollmer University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

Catherine Vozzo Division of Gastroenterology, University Hospitals of Cleveland, Case Western Reserve University School of Medicine, Cleveland, OH, USA

Timothy J. Vreeland Brooke Army Medical Center, Fort Sam Houston, TX, USA

R. Matthew Walsh Department of General Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH, USA

Jane Wang Department of Surgery, University of California, San Francisco, San Francisco, CA, USA

Paul Wong Department of Surgery, City of Hope National Medical Center, Duarte, CA, USA