

# Mechanical Circulatory Support in End-Stage Heart Failure



A Practical Manual

Andrea Montalto  
Antonio Loforte  
Francesco Musumeci  
Thomas Krabatsch  
Mark S. Slaughter *Editors*



Springer

Andrea Montalto  
Antonio Loforte  
Francesco Musumeci  
Thomas Krabatsch  
Mark S. Slaughter  
*Editors*

# **Mechanical Circulatory Support in End-Stage Heart Failure**

A Practical Manual

In collaboration with Cristiano Amarelli



**Springer**



*Editors*

**Andrea Montalto**

San Camillo-Forlanini Hospital  
Rome, Italy

**Antonio Loforte**

Cardiac Surgery  
S.Orsola-Malpighi Hospital  
Bologna, Italy

**Francesco Musumeci**

San Camillo-Forlanini Hospital  
Rome, Italy

**Thomas Krabatsch**

Deutsches Herzzentrum Berlin  
Berlin, Germany

**Mark S. Slaughter**

Department of Cardiovascular  
and Thoracic Surgery  
University of Louisville  
Louisville, KY, USA

ISBN 978-3-319-43381-3

ISBN 978-3-319-43383-7 (eBook)

DOI 10.1007/978-3-319-43383-7

Library of Congress Control Number: 2017943505

© Springer International Publishing Switzerland 2017

This work is subject to copyright. All rights are reserved 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, express 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.

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer International Publishing AG

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Mechanical Circulatory Support in End-Stage Heart Failure





*To all patients whose desire for a better life inspired me*

*Andrea Montalto*

*To my beloved daughter, Alessandra, and wife, Elisa*

*Antonio Loforte*

*To my relatives and friends  
who cared and loved me, supporting my curiosity and perseverance after the loss  
of my father*

*Cristiano Amarelli*



## Preface

---

» *We are all God's knights and knights of life.*

*This is my destiny, this is the message that God tells me to bring.*

*A message of life and hope for me and for others.*

*Whatever happens do not close my sufferings in a drawer or a sad thought.*

*I was always smiling. Remember my smile and my will to live.*

*Go ahead and tell it so that it can be of relief and hope for others.*

*It should be a happy memory.*

*So in the worst case a knight will become an angel.*

*Mario C.*

End-stage acute and chronic heart failure refractory to maximal pharmacological therapy carries a poor chance of survival for patients unless they undergo heart transplantation. Heart transplantation is restricted by age and comorbidities to a small group of patients, and the actual donor's shortage does not meet properly the demand of patients on waiting list. Mechanical circulatory support is a valid temporary solution before heart transplantation, whose results are playing the role of a game-changer in such a challenging field. The choice and management of the right device for every patient remains tricky. Giving the equipoise of the short and even the midterm results between LVADs and heart transplantation experienced in the last decade, the use as destination therapy is gaining space, permitting to promptly treat a wider patient population. Prompt availability and cost-effectiveness as unique constraint are the mainstreams of the mechanical solution. The proper selection of candidates for VAD or TAH implantation remains a challenging clinical decision. Patients who are too compromised may

have an elevated risk of mortality post-operatively while patients with an early heart dysfunction scenario may have a poor benefit, thus being more exposed to device-related complications. Preoperative hemodynamic and clinical scenarios which may occur are extremely different from those the clinicians routinely have to face up to with traditional cardiac surgery therapy. Proper management and interpretation of MCS-related complications is an additional concern to deal with particularly in the case of non-hub and well-trained centers. Moreover, the psychological aspects and views of long-term VAD/TAH recipients which may influence the overall outcome should not be underestimated.

The complexity of MCS therapy and its clinical landscape, as well as the devotion of free minds in discovering, always case by case, the adequate treatment of such a delicate patient population, stimulated all of us to develop such an ambitious project. We aimed at building a textbook that would be a practical guide in terms of correct and well-accepted management of patients undergoing implantation of VAD and TAH. Our goal was to move up from a pioneer's phase of MCS adopted in few centers in the world to a world-wide standardized and shared management of a such effective therapy. In order to accomplish all of the above, we approached all those renowned centers and physicians worldwide who, over the years, have spent interest and time mostly in studying deeply such a delicate medicine field which is heart failure mechanical treatment. We encouraged all authors to enrich their contributions with tables and algorithms in order to render each chapters adoptable as a guiding protocol, thus providing keys for the resolution of any kind of traditionally discussed issue. Our goal has been

welcomed with great enthusiasm by all authors who have fully grasped the essence of this project. It is therefore with great satisfaction that we thank all those who, despite the onerous work commitments,

have devoted their time to the realization of this book which we hope will be a valuable tool to improve survival and quality of life of those people who are living thanks to an artificial heart support system.

**Andrea Montalto**

Rome, Italy

**Antonio Loforte**

Bologna, Italy

**Francesco Musumeci**

Rome, Italy

**Thomas Krabatsch**

Berlin, Germany

**Mark S. Slaughter**

Louisville, USA



# Editors and Contributors

---

## About the Editors

---



### **Thomas Krabatsch, MD, PhD**

Dr. Krabatsch is senior cardiac surgeon at the Deutsches Herzzentrum in Berlin with expertise in the surgical treatment of a variety of cardiovascular diseases in adults including severe diffuse coronary artery disease and valvular heart diseases, in mechanical circulatory support, and in transplantation. He is the director of the Deutsches Herzzentrum Berlin's mechanical circulatory support team, which has carried out over 2800 implants. Dr. Krabatsch's basic science research interests include processes and mechanisms at the machine-human body interface, pump technology, and heart failure. He is a member of the ISHLT, EACTS, DGTHG, the German Society for Gene Therapy, and the BBGKH and author or coauthor of more than 150 scientific articles. Dr. Krabatsch also collaborates with several universities and cardiosurgical hospitals in Eastern Europe, such as Russia, Belarus, Bosnia, and Hungary. He is honorary professor in one of the Russian largest medical schools.



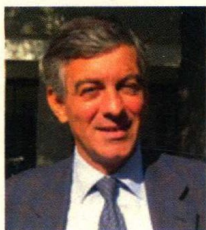
### **Dr. Antonio Loforte, MD, PhD**

Dr. Loforte is currently staff surgeon and cochair of the mechanical circulatory support program at the Department of Cardiothoracic, Transplantation and Vascular Surgery, S. Orsola Hospital, University of Bologna, Italy. He completed his cardiothoracic surgery residency at the University of Bologna, S. Orsola Hospital (Italy); at St. Antonius Ziekenhuis, Nieuwegein (the Netherlands); and the Deutsches Herzzentrum Berlin (Germany). He additionally joined the Michael E. DeBakey Department of Surgery, Division of Transplant and Assist Devices, in Houston, Texas, USA. Dr. Loforte is member of a number of professional organizations including the prestigious STS, ISHLT, ASAIO, EACTS, RHICS, and SICCH among others. His bibliography lists over 60 peer-reviewed original articles, 180 abstracts (communications) for international meetings and 10 book chapters. He serves as a reviewer for 21 international journals and is on the editorial board in 9. He got a "European PhD label" in organ transplantation and three international awards in Europe and the USA.

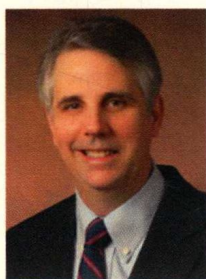


### **Dr. Andrea Montalto, MD**

Dr. Montalto obtained his medical degree at the University of Naples "Federico II" School of Medicine in Naples, Italy. After completing the residency in cardiac surgery at the University of Naples Federico II, he completed his training at the Cardiac Surgery Center of the San Camillo Hospital in Rome, Italy. Since 2006, he is permanent staff surgeon at the Department of Cardiac Surgery and Transplantation of the San Camillo Hospital. Dr. Montalto has shown particular interest in the field of surgical treatment of advanced heart failure, becoming familiar with the management of patients implanted with mechanical devices and is head of the VAD program of the Cardiac Surgery Center at the San Camillo Hospital since 2012. He is an active member of SICCH and EUROMACS.

**Francesco Musumeci, MD, FECTS**

Dr. Musumeci is director of the Cardiac Surgery and Transplantation and director of the Department of Cardiovascular Medicine at the San Camillo Hospital in Rome, Italy. He had his cardiac surgical training in London and between 1987 and 1990 he was senior registrar at the Harefield Hospital. In 1991 he was appointed consultant cardiac surgeon at the University Hospital of Wales. In 1998 moved back to Rome as director of Cardiac Surgery at the San Camillo Hospital. His clinical interests have been focused on heart failure surgery including transplantation and mechanical circulatory support and on minimally invasive surgery which is the standard surgical approach for all valve pathologies. In November 2011 the Robot Assisted Cardiac Surgical Program was started. The department has also a large experience in TAVI. Dr. Musumeci is elected president of the SICCH (Italian Society of Cardiac Surgery) for the years 2017–2018.

**Dr. Mark S. Slaughter, MD**

Dr. Slaughter is professor of surgery and chair of the Department of Cardiovascular and Thoracic Surgery at the University of Louisville, KY, USA, and is an adjunct professor in the Department of Bioengineering. Dr. Slaughter currently serves as a consultant to the FDA Medical Device Review Panel and a National Science Foundation SBIR/STTR grant reviewer and previously served two terms for the Health and Human Services Medicare Coverage Advisory Committee. In addition, he serves on the Ethics Committee and the Education Committee for the American Association for Thoracic Surgery and is a councilor for the Southern Thoracic Surgical Association. Dr. Slaughter has served as the president of the American Society for Artificial Internal Organs and president of the International Society for Rotary Blood Pumps. He currently is the editor in chief of the *American Society for Artificial Internal Organs* journal and also serves as an associate editor for the *Annals of Thoracic Surgery*.



## Contributors

---

### Robert M. Adamson

Department of Cardiothoracic Surgery  
Sharp Memorial Hospital  
San Diego, CA, USA

### Larry A. Allen

Section of Advanced Heart Failure  
Division of Cardiology  
University of Colorado School of Medicine  
Aurora, CO, USA

### Cristiano Amarelli

Department of Cardiovascular Surgery  
and Transplantation  
Monaldi Hospital  
Naples, Italy

### Antonio Amodeo

Department of Pediatric Cardiac Surgery  
Ospedale Pediatrico Bambino Gesù  
Rome, Italy

### Emanuela Angeli

Department of Pediatric Cardiac Surgery and  
Transplantation  
S. Orsola-Malpighi Hospital, Bologna  
University  
Bologna, Italy

### Martine Antoine

Department of Cardiac Surgery  
Erasmus Hospital, Free University of Brussels  
Brussels, Belgium

### Francisco A. Arabia

Heart Institute, Cedars-Sinai Medical Center  
Los Angeles  
California, USA

### Matteo Attisani

Division of Cardiac Surgery  
Città della Salute e della Scienza University  
of Turin  
Turin, Italy

### Lorenzo Bagozzi

Division of Cardiac Surgery  
Department of Cardiac  
Thoracic and Vascular Sciences  
University of Padua  
Padova, Italy

### Massimo Baiocchi

Anesthesia and Intensive Care Unit  
Cardiovascular and thoracic Department  
S. Orsola-Malpighi University Hospital Bologna  
Bologna, Italy

### Alessandro Barbone

Department of Cardiac Surgery  
Istituto Clinico Humanitas  
Rozzano, Milan, Italy

### Rachel A. Beaupré

Center for Circulatory Support  
Texas Heart Institute  
Baylor College of Medicine  
Houston, TX, USA

### Jonida Bejko

Division of Cardiac Surgery  
Department of Cardiac, Thoracic and Vascular  
Sciences  
University of Padua  
Padua, Italy

### Fabio Bellotto

Preventive Cardiology and Rehabilitation  
Institute Codivilla-Putti  
Cortina D'Ampezzo, Italy

### Giovanni Benedetti

Cardiothoracic Department  
University Hospital  
Udine, Italy

### M. Benedetto

Anesthesia and Intensive Care Unit  
Campus BioMedico University Hospital  
Rome, Italy

### Felix Berger

Department of Pediatric Cardiology  
and Congenital Heart Diseases  
Deutsches Herzzentrum Berlin  
Berlin, Germany

### Giacomo Bortolussi

Division of Cardiac Surgery  
Department of Cardiac, Thoracic and  
Vascular Sciences  
University of Padua  
Padua, Italy



**Robin Bostic**

Thoratec Inc.  
Pleasanton, CA, USA

**Tomaso Bottio**

Division of Cardiac Surgery  
Department of Cardiac, Thoracic  
and Vascular Sciences  
University of Padua  
Padua, Italy

**Nicolas A. Brozzi**

University of Miami  
Division of Thoracic Transplant  
and Mechanical Circulatory Support  
Miami, FL, USA

**Holger Buchholz**

Integrative Health Institute (IHI)  
University of Alberta  
Edmonton, AB, Canada

**Marianna Buonocore**

AZ Sint Jan  
Brugge, Belgium

**Edward J Burke**

Thoratec Inc.  
Pleasanton, CA, USA

**Alain Carpentier**

Department of Cardiovascular Surgery  
Hôpital Européen Georges Pompidou  
Assistance Publique-Hôpitaux de Paris  
Université Paris Descartes  
Paris, France

**Lucio Careddu**

Department of Pediatric Cardiac Surgery  
and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Evaristo Castedo**

Espamacs and Hospital Universitario Puerta  
de Hierro Majadahonda  
Madrid, Spain

**Katherine Chorpennig**

HeartWare Inc.  
Miami, FL, USA

**Dawn M. Christensen**

MyLVAD, Innovative Program Solutions, LLC  
Pine Grove, PA, USA

**Manlio Cipriani**

"A. de Gasperi" CardioCenter  
Niguarda Great Metropolitan Hospital  
Milan, Italy

**Colleen Pietras**

Division of Cardiovascular Surgery  
Mayo Clinic  
Rochester, MN, USA

**Leonida Compostella**

Preventive Cardiology and Rehabilitation  
Institute Codivilla-Putti  
Cortina D'Ampezzo, Italy

**Jennifer Conway**

Integrative Health Institute (IHI)  
University of Alberta  
Edmonton, AB, Canada

**Jack Copeland**

UCSD Cardiovascular Center  
The University of Arizona Health Network  
University of Arizona  
Tucson, USA

**Michael Dandel**

Department of Cardiology  
Deutsches Herzzentrum Berlin  
Berlin, Germany

**Theo M.M.H. de By**

Euromacs e.V. c/o Deutsches Herzzentrum  
Berlin  
Berlin, Germany

**Fabrizio De Rita**

Department of Congenital Cardiothoracic  
Surgery  
Freeman Hospital  
Newcastle Upon Tyne, UK

**Ezin Deniz**

Department of Cardiothoracic, Transplantation  
and Vascular Surgery  
Hannover Medical School  
Hannover, Germany

**Walter P. Dembistky**

Department of Cardiothoracic Surgery  
Sharp Memorial Hospital  
San Diego, CA, USA

**Arianna Di Molfetta**

Bambino Gesù Childrens Hospital  
Department of Pediatric Cardiac  
Surgery  
MCS Unit  
Rome, Italy

**S. Ersel**

Berlin Heart GmbH  
Berlin, Germany

**David Feldman**

University of Cincinnati Medical Center  
Cincinnati, OH, USA

**Christina Feldmann**

Department of Cardiothoracic, Transplantation,  
and Vascular Surgery  
Hannover Medical School  
Hannover, Germany

**Sergio Filippelli**

Department of Pediatric Cardiac  
Surgery  
Ospedale Pediatrico Bambino Gesù  
Rome, Italy

**Arnt E. Fiane**

Department of Cardiothoracic Surgery  
and Transplantation  
Oslo University Hospital  
Oslo, Norway

**Rodger G. Ford**

ReliantHeart Inc.  
Houston, TX, USA

**O.H. Frazier**

Center for Cardiac Support, Cardiovascular  
Surgery Research  
Texas Heart Institute University of Texas Health  
Science Center in Houston  
Houston, TX, USA  
e-mail: lschwenke@texasheart.org

**Guido Frascaroli**

Anesthesia and Intensive Care Unit,  
Cardiovascular and Thoracic Department  
S. Orsola-Malpighi University Hospital Bologna  
Bologna, Italy

**Maria Frigerio**

"A. de Gasperis" CardioCenter  
Niguarda Great Metropolitan Hospital  
Milan, Italy

**Gaetano Gargiulo**

Department of Pediatric Cardiac Surgery  
and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Gino Gerosa**

Division of Cardiac Surgery  
Department of Cardiac, Thoracic  
and Vascular Sciences  
University of Padua  
Padua, Italy

**Paul W. Goetz**

Division of Cardiac Surgery  
Department of Surgery and Department  
of Psychiatry Feinberg School of Medicine  
Chicago, IL, USA

**Andrew B. Goldstone**

Department of Cardiothoracic Surgery  
Stanford University school of Medicine  
California, USA

**Kathleen L. Grady**

Division of Cardiac Surgery  
Feinberg School of Medicine  
Northwestern University  
Chicago, IL, USA

**Francesco Grigioni**

Department of Cardiology and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy  
e-mail: francesco.grigioni@unibo.it



**Jan Gummert**

Department of Cardiothoracic Surgery  
Heart and Diabetes Center  
North Rhine-Westphalia  
Bad Oeynhausen, Germany

**Shelley A. Hall**

Department of Cardiac Transplant  
Baylor University Medical Center at Dallas  
Dallas, TX, USA

**Margaret M. Hannan**

Mater Misericordiae University Hospital  
University College Dublin  
Dublin, Ireland

**Jasmin S. Hanke**

Department of Cardiothoracic, Transplantation,  
and Vascular Surgery  
Hannover Medical School  
Hannover, Germany

**Asif Hasan**

Department of Congenital Cardiothoracic  
Surgery  
Freeman Hospital  
Newcastle Upon Tyne, UK

**Axel Haverich**

Department of Cardiothoracic, Transplantation,  
and Vascular Surgery  
Hannover Medical School  
Hannover, Germany

**Michael Hübler**

University Children's Hospital  
Department of Congenital Pediatric Surgery  
Zurich, Switzerland

**Piet Jansen**

Carmat SA  
Vélizy-Villacoublay, France

**Robert Jarvik**

Jarvik Heart Inc.  
New York, USA

**David L. Joyce**

Division of Cardiovascular Surgery Mayo Clinic  
Rochester, MN, USA

**Friedrich Kaufmann**

Department of Cardiothoracic and Vascular  
Surgery  
Deutsches Herzzentrum Berlin  
Berlin, Germany

**Reiner Koerfer**

Klinikum Niederrhein, Department of Thoracic  
and Cardiovascular Surgery  
Duisburg, Germany

**Andreas Koster**

Department of Anesthesiology,  
Heart and Diabetes Center North  
Rhine-Westphalia  
Bad Oeynhausen, Germany

**Thomas Krabatsch**

Department of Cardiothoracic  
and Vascular surgery  
Deutsches Herzzentrum Berlin  
Berlin, Germany

**Marian Kukucka**

Department of Anesthesiology  
Deutsches Herzzentrum Berlin  
Berlin, Germany

**Mark Lamotte**

Physiotherapy and Rehabilitation  
Department  
Erasme Hospital, Free University  
of Brussels  
Brussels, Belgium

**Jeff A. LaRose**

HeartWare Inc.  
Miami, FL, USA

**Christian Latrémouille**

Department of Cardiovascular Surgery  
Hôpital Européen Georges Pompidou,  
Assistance Publique-Hôpitaux de Paris  
Université Paris Descartes  
Paris, France

**Karl K. Limmer**

Department of Cardiothoracic Surgery  
Sharp Memorial Hospital  
San Diego, CA, USA



**Ugolino Livi**

Cardiothoracic Department  
University Hospital  
Udine, Italy

**Matthias Loebe**

Leonard M. Miller School of Medicine at  
University of Miami  
Division of Thoracic Transplant and Mechanical  
Circulatory Support  
Miami, FL, USA

**Antonio Loforte**

Department of Cardiovascular Surgery and  
Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Angela Lorts**

Cincinnati Children's Hospital Medical Center  
Cincinnati, OH, USA

**Ciro Maiello**

Department of Cardiovascular Surgery and  
Transplantation  
Monaldi Hospital, Az. dei Colli  
Naples, Italy

**Simon Maltais**

Department of Cardiac Surgery Mayo Clinic  
Rochester, MN, USA

**Ares K. Menon**

Berlin Heart GmbH  
Berlin, Germany

**Giuseppe Marinelli**

Department of Cardiovascular Surgery  
and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Antonella Marino**

Ventricular Assist Devices, Vega S.p.A  
Bollate, Italy

**Marco Masetti**

Department of Cardiology and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Anna L. Meyer**

Department of Cardiothoracic Surgery  
Heart Center Leipzig, University of Leipzig  
Leipzig, Germany

**Bart P. Meyns**

Department of Cardiac Surgery  
Katholieke Universiteit Leuven  
Leuven, Belgium

**Oliver Miera**

Department of Pediatric Cardiology  
and Congenital Heart Diseases  
Deutsches Herzzentrum Berlin  
Berlin, Germany

**Carmelo A. Milano**

Department Cardiovascular and Thoracic  
Surgery Duke University Medical Center  
Durham, NC, USA

**Nader Moazami**

Kaufman Center for Heart Transplantation and  
Mechanical Circulatory Support - Department  
of Thoracic and Cardiovascular Surgery,  
Cleveland Clinic  
Department of Biomedical Engineering  
Lerner Institute of Research  
Cleveland, OH, USA

**Paul Mohacsi**

Department of Cardiology  
Swiss Cardiovascular Center  
University Hospital (Inselspital)  
Bern, Switzerland

**Andrea Montalto**

Department of Cardiac Surgery and Heart  
Transplantation  
San Camillo Hospital  
Rome, Italy

**David L.S. Morales**

Department of Cardiothoracic Surgery  
The Heart Institute Cincinnati Children's  
Hospital Medical Center  
University of Cincinnati College of Medicine  
Cincinnati, OH, USA

**Jeffrey A. Morgan**

Center for Cardiac Support, Cardiovascular  
Surgery Research  
Texas Heart Institute  
University of Texas Health Science Center in  
Houston  
Houston, TX, USA

**Francesco Moscato**

Center for Medical Physics and Biomedical  
Engineering  
Medical University of Vienna, Ludwig  
Boltzmann Cluster for Cardiovascular Research  
Vienna, Austria

**Francesco Musumeci**

Director of Cardiovascular Medicine  
Director of Cardiac Surgery and Transplantation  
San Camillo-Forlanini Hospital  
Rome, Italy

**Yoshifumi Naka**

Division of Cardiac, Thoracic and Vascular  
Surgery  
Columbia University Medical Center  
New York, NY, USA

**Ivan Netuka**

Department of Cardiac Surgery  
Institute for Clinical and Experimental Medicine  
Charles University in Prague  
Prague, Czech Republic

**Alina Nicoara**

Duke University Medical Center  
Durham, NC, USA

**Fabrizio Oliva**

"A. de Gasperis" CardioCenter  
Niguarda Great Metropolitan Hospital  
Milan, Italy

**Helena Ortis**

Cardiothoracic Department  
University Hospital  
Udine, Italy

**Federico Pappalardo**

Department of Anesthesia and Intensive Care  
IRCCS San Raffaele Scientific Institute  
Milan, Italy

**Centofanti Paolo**

Division of Cardiac Surgery  
Città della Salute e della Scienza University  
of Turin  
Turin, Italy

**Christopher Parker**

Thoratec Inc.  
Pleasanton, CA, USA

**Gianluigi Perri**

Department of Pediatric Cardiac Surgery  
Ospedale Pediatrico Bambino Gesù  
Rome, Italy

**Vito Piazza**

Division of Cardiology  
Department of Cardiac Surgery and Heart  
Transplantation  
San Camillo Hospital  
Rome, Italy  
vitopiazza@inwind.it

**Marina Pieri**

Department of Anesthesia and Intensive Care  
IRCCS San Raffaele Scientific Institute  
Milan, Italy

**Massimiliano Polastri**

Physical Medicine and Rehabilitation  
University Hospital S. Orsola-Malpighi  
Bologna, Italy

**Evgenij Potapov**

Department of Cardiothoracic and Vascular  
Surgery  
Deutsches Herzzentrum Berlin  
Berlin, Germany



**Luciano Potena**

Department of Cardiology and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Luca Ragni**

Department of Pediatric Cardiac Surgery  
and Transplantation  
S. Orsola-Malpighi Hospital  
Bologna University  
Bologna, Italy

**Mauro Rinaldi**

Division of Cardiac Surgery  
Città della Salute e della Scienza  
University of Turin  
Turin, Italy

**Sebastian V. Rojas**

Department of Cardiothoracic, Transplantation,  
and Vascular Surgery  
Hannover Medical School  
Hannover, Germany

**Diyar Saeed**

Department of Cardiovascular Surgery  
Heinrich-Heine University of Düsseldorf  
Düsseldorf, Germany

**Anna Mara Scandroglio**

Department of Anesthesia and Intensive  
Care  
IRCCS San Raffaele Scientific Institute  
Milan, Italy

**Heinrich Schima**

Center for Medical Physics and Biomedical  
Engineering  
Medical University of Vienna, Ludwig  
Boltzmann Cluster for Cardiovascular  
Research  
Vienna, Austria

**Thomas Schlöglhofer**

Center for Medical Physics and Biomedical  
Engineering  
Department of Cardiac Surgery Medical  
University of Vienna  
Vienna, Austria

**K.R. Schmitt**

Department of Pediatric Cardiology and  
Congenital Heart Diseases  
Deutsches Herzzentrum Berlin  
Berlin, Germany

**Jan D. Schmitto**

Department of Cardiothoracic, Transplantation,  
and Vascular Surgery  
Hannover Medical School  
Hannover, Germany

**Stephan Schueler**

Department of Cardiothoracic Surgery  
Newcastle Upon Tyne Freeman Hospital  
Newcastle Upon Tyne, UK

**Martin Schweiger**

University Children's Hospital  
Department of Congenital Pediatric  
Surgery  
Zurich, Switzerland

**Melody Sherwood**

Department of Cardiac Transplant  
University Medical Center at Dallas  
Dallas, TX, USA

**Yasuhiro Shudo**

Department of Cardiothoracic  
Surgery  
Stanford University school of Medicine  
Stanford, CA, USA

**Mark S. Slaughter**

Professor and Chair  
Department of Cardiovascular  
and Thoracic Surgery  
University of Louisville  
Louisville, KY, USA

**Gro Sorenson**

Oslo University Hospital  
Oslo, Norway

**Sotirios Spiliopoulos**

Department for the Surgical Therapy of  
End-stage Heart Failure and Mechanical  
Circulatory Support  
Heart and Vascular Center Duisburg  
Duisburg, Germany