

---

---

# FIRST VIENNA SHOCK FORUM

## Part A: Pathophysiological Role of Mediators and Mediator Inhibitors in Shock

Proceedings of the First Vienna Shock Forum held May 1-3, 1986

---

---

Editors

**Günther Schlag**  
**Heinz Redl**

Ludwig Boltzmann Institute  
for Experimental Traumatology  
Vienna, Austria

---

ALAN R. LISS, INC. • NEW YORK

**Address all Inquiries to the Publisher  
Alan R. Liss, Inc., 41 East 11th Street, New York, NY 10003**

---

**Copyright © 1987 Alan R. Liss, Inc.**

---

**Printed in the United States of America**

Under the conditions stated below the owner of copyright for this book hereby grants permission to users to make photocopy reproductions of any part or all of its contents for personal or internal organizational use, or for personal or internal use of specific clients. This consent is given on the condition that the copier pay the stated per-copy fee through the Copyright Clearance Center, Incorporated, 27 Congress Street, Salem, MA 01970, as listed in the most current issue of "Permissions to Photocopy" (Publisher's Fee List, distributed by CCC, Inc.), for copying beyond that permitted by sections 107 or 108 of the US Copyright Law. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

**Library of Congress Cataloging-in-Publication Data**

Vienna Shock Forum (1st : 1986)

First Vienna Shock Forum.

(Progress in clinical and biological research ; 236)

Contents: pt. A. Pathophysiological role of mediators and mediator inhibitors in shock—pt. B. Monitoring and treatment of shock.

Includes bibliographies and index.

1. Shock—Congresses. I. Schlag, Günther.

II. Redl, Heinz. III. Title. IV. Series: Progress in clinical and biological research ; v. 236. [DNLM: 1. Monitoring, Physiologic—congresses. 2. Shock—physiopathology—congresses. 3. Shock—therapy—congresses.

W1 PR668E v.236 / QZ 140 V662 1987f]

RB150.S5V54 1987 616'.047 87-3921

ISBN 0-8451-5086-3 (set)

ISBN 0-8451-0196-X (pt. A)

ISBN 0-8451-0197-8 (pt. B)



# Contents

<b>Contributors</b> . . . . .	<b>xiii</b>
<b>Contents of Part B</b> . . . . .	<b>xxiii</b>
<b>Preface</b>	
Günther Schlag and Heinz Redl . . . . .	<b>xxv</b>
<b>1. THE PATHOPHYSIOLOGICAL ROLE OF MEDIATORS AND INHIBITORS THEREOF IN SHOCK</b>	
<b>1.1. Complement—Granulocytes</b>	
<b>Complement Activity in Shock</b>	
Mats Heideman and Anders Bengtson . . . . .	<b>3</b>
<b>Inflammatory Mediators in Patients With Ischemic Limbs</b>	
Anders Bengtson, Pia Holmberg, and Mats Heideman . . . . .	<b>11</b>
<b>Granulocytes as Mediators of Tissue Injury in Shock: Therapeutic Implications</b>	
Dale E. Hammerschmidt and Gregory M. Vercellotti . . . . .	<b>19</b>
<b>Role of Fibrin-Neutrophil Interactions in Lung Vascular Injury</b>	
Asrar B. Malik . . . . .	<b>33</b>
<b>Quantitative Estimation of Leukostasis in the Posttraumatic Lung—Canine and Human Autopsy Data</b>	
Heinz Redl, Hans P. Dinges, and Günther Schlag . . . . .	<b>43</b>
<b>Whole Body Inflammation in Trauma Patients; an Autopsy Study</b>	
Hans K.S. Nuytinck, Xavier J.M.W. Offermans, Karel Kubat, and R. Jan A. Goris . . . . .	<b>55</b>
<b>White Cells in Shock Ischemia</b>	
David H. Lewis, Anders Gidlöf, Kristina E-dr. Behm, Maj-Britt Bengtsson, and Angela Menschik . . . . .	<b>63</b>
<b>Neutrophil Protease Enzymes and Oxygen Free Radicals as Mediators of Pulmonary Membrane Damage</b>	
Stephen Westaby . . . . .	<b>75</b>
<b>1.2. Proteases</b>	
<b>Studies on Shock During Extracorporeal Circulation During Aorto-Coronary Bypass Operations</b>	
Wolfgang Heller, Günther Fuhrer, Hans-Eberhard Hoffmeister, and Michael J. Gallimore . . . . .	<b>87</b>

<b>Biochemical Monitoring of the Lung During and After Extracorporeal Circulation</b>	
Geza Horpacsy, Werner Hügel, Hugo Müller, and Alfred Geißler . . . . .	95
<b>Effect of Elevated C1-Esterase Inhibitor Levels on Elastase Release In Vitro—A Proposed Model of Shock (ECC)</b>	
Wolfgang Heller, Günther Fuhrer, Susanne Hoberg, Hans-Eberhard Hoffmeister, and Anton Philipitsch . . . . .	107
<b>Granulocyte Elastase and White Cell Counts in Septic Pigs</b>	
M. Siebeck, H. Hoffmann, and R. Geiger . . . . .	115
<b>Influence of the Lysosomal Elastase Inhibitor Eglin on the Development of Interstitial Lung Edema in <i>E. coli</i> Bacteremia in Pigs</b>	
H.F. Welter, M. Siebeck, O. Thetter, and M. Jochum . . . . .	121
<b>Evaluation of the Kinin-Induced Pathomechanisms in the Development of ARDS by Kallikrein Inhibition In Vivo</b>	
O. Thetter, H. Hoffmann, M. Siebeck, H.F. Welter, and H. Fritz . . . . .	127
<b>Local Activation of the Kallikrein-Kinin System in the Lung Following <i>E. coli</i> Sepsis in Sheep</b>	
Svenerik Andreasson, Lennart Smith, Ansgar O. Aasen, and Bo Risberg . . . . .	133
<b>C1-Esterase Inhibitor in Early Septicemia</b>	
M. Siebeck, A. Philipitsch, H. Wiesinger, and H.F. Welter . . . . .	141
<b>Anti-Proteases in Endotoxemia</b>	
Daniel L. Traber . . . . .	149
<b>Effect of Aprotinin and C1-Esterase Inhibitor on Activation of the Plasma Kallikrein-Kinin System In Vivo</b>	
H. Hoffmann, M. Siebeck, O. Thetter, E. Fink, and A. Philipitsch . . . . .	159
<b>Cellular Effects of Aprotinin</b>	
Heinz Redl, Anna Schiesser, Eva Paul, Claudia Wilfing, and Günther Schlag . . . . .	165
<b>Feasibility Study of Very High Aprotinin Dosage in Polytrauma Patients</b>	
C. Clasen, M. Jochum, and W. Mueller-Esterl . . . . .	175
<b>Hemodynamics and Proteolysis in Experimental Trypsin Induced Shock</b>	
Froye Naess, Johan Pillgram-Larsen, Tom E. Ruud, Jan O. Stadaas, and Ansgar O. Aasen . . . . .	185
<b>Protease Inhibitor Infusion Improves Survival Rate and Hemodynamics in Experimental Pancreatic Shock</b>	
Tom E. Ruud, Ansgar O. Aasen, Johan Pillgram-Larsen, and Jan O. Stadaas . . . . .	193
<b>Biologic Availability of Injected or Aerosolized Alpha<sub>1</sub> Proteinase Inhibitor</b>	
R.M. Smith, R.G. Spragg, and K.M. Moser . . . . .	203
<b>Multitherapy: A New Treatment Regimen in Endotoxemia</b>	
Ansgar O. Aasen, Tom E. Ruud, Johan Pillgram-Larsen, and Jan O. Stadaas . . . . .	211
<b>Hemodynamic Consequences of Multitherapy Pretreatment in Experimental Endotoxemia</b>	
J. Pillgram-Larsen, T.E. Ruud, J.O. Stadaas, and A.O. Aasen . . . . .	227

**1.3 Oxygen Radicals—Lipid Peroxidation**

<b>Oxygen Radicals and Lipid Peroxidation in Experimental Shock</b> Gerd O. Till and Peter A. Ward . . . . .	235
<b>Cytotoxic Lipid Peroxidation Products</b> Hermann Esterbauer, Ernst Koller, Peter Heckenast, Robert Moser, and Claude Celotto . . . . .	245
<b>Oxidant Injury of Cultured Cells: Biochemical Consequences</b> R.G. Spragg, I.U. Schraufstatter, P.A. Hyslop, D.B. Hinshaw, and C.G. Cochrane . . . . .	253
<b>Oxygen Radicals Scavenging in Prophylaxis and Treatment of Experimental Shock</b> G.P. Novelli, P. Angiolini, G. Martini, and R. Tani . . . . .	259
<b>Antioxidant Drugs and Shock Therapy</b> O. Ortolani, M. Biasiucci, A. Trebbi, M. Cianciulli, and R. Cuocolo . . . . .	271
<b>Protection by Ebselen Against Endotoxin Shock in Rats or Mice Sensitized by Galactosamine</b> K.-H. Konz, G. Tiegs, and A. Wendel . . . . .	281

**1.4. Prostaglandins, Leukotrienes, and Platelet Activation Factor**

<b>Activation of the Pulmonary Arachidonic Acid System and Its Consequences for Hemodynamics and Fluid Balance</b> Heinz Neuhof, Werner Seeger, and Norbert Suttrop . . . . .	289
<b>Leukotrienes as Mediators in Endotoxin Shock and Tissue Trauma</b> Dietrich Keppler, Wolfgang Hagmann, and Claudio Denzlinger . . . . .	301
<b>Generation of Leukotrienes in Polytraumatic Patients With Adult Respiratory Distress Syndrome (ARDS)</b> J. Knöller, W. Schönfeld, T. Joka, J. Sturm, and W. König . . . . .	311
<b>On the Pathogenesis of Adult Respiratory Distress Syndrome—The Role of Anaphylatoxins, Leukotrienes and Platelet Activating Factor</b> U. Pison, K.P. Schmit-Neuerburg, and W. König . . . . .	317
<b>Increased Hemodynamic and Survival With Endotoxin and Septic Shock With Ibuprofen Treatment</b> Roger C. Bone, Elizabeth Rogers Jacobs, and Frank J. Wilson, Jr. . . . .	327
<b>Effect of Ibuprofen on Components of an Acute Systemic Inflammatory Response Evoked by Intravenous Endotoxin Administration in the Conscious Sheep</b> Gary J. Jesmok, Frederick Aono, Janet Simpson, and Julian Borgia . . . . .	333
<b>Effect of the Nonsteroidal Antiinflammatory Agent BW755C in Rat and Sheep Endotoxemia</b> Soheyl Bahrami, Fred Mihm, Martin Thurnher, Christa Vogl, Anna Schiesser, Heinz Redl, and Günther Schlag . . . . .	347

<b>Effectiveness of Prostaglandin E<sub>1</sub> in Adult Respiratory Distress Syndrome</b> William C. Shoemaker . . . . .	361
<b>Efficiency of Prostacyclin in Rabbit Endotoxin Shock</b> Heinrich Ditter, Peter Röttger, Reinhard Voss, and F. Reinhard Matthias . . . . .	369
<b>1.5 Endotoxin</b>	
<b>Endotoxin: The Causative Factor of Mediator Release During Sepsis</b> Daniel L. Traber . . . . .	377
<b>Endotoxin Shock Model in the Dog: A Reevaluation</b> Jean-Louis Vincent, Marc Domb, Pascal Luypaert, Corinne De Boelpaep, Philippe Van der Linden, and Serge Blécic . . . . .	393
<b>Perturbation of Transmembrane Signaling Mechanisms in Acute and Chronic Endotoxemia</b> Judy A. Spitzer, Elena R. Turco, Ion V. Deaciuc, and Bryan L. Roth . . . . .	401
<b>Endotoxin-Induced Generation of Oxygen Free Radicals in Freshly Drawn Human Blood</b> Hubert Reichle, Dagmar Langner, Peter Wendt, and Günther Blümel . . . . .	419
<b>Inhibition of Lipopolysaccharide-Mediated Activation of Neutrophils With Monosaccharide Derivatives of Lipid A</b> Charles Lam, Elizabeth Basalka, Eberhard Schütze, and Hubert Walzl . . . . .	427
<b>2. RESULTS OF MEDIATOR RELEASE</b>	
<b>Physiologic and Metabolic Correlations in Human Septic Shock</b> John H. Siegel . . . . .	439
<b>Multisystem Organ Failure</b> Hans-Peter Schuster . . . . .	459
<b>Changes in Metabolic Control in Injury and Sepsis</b> Rod A. Little and Keith N. Frayn . . . . .	463
<b>Catecholamines in the Serum of Multiple Trauma Patients—Mediators of ARDS?</b> P. Sefrin . . . . .	477
<b>Increased Systemic Microvascular Permeability in Septic Shock</b> A.B. Johan Groeneveld and Lambertus G. Thijs . . . . .	487
<b>Differences in Regional Oxygen Supply, Oxygen Consumption and Blood Flow During the Onset of E. coli Sepsis</b> G.I.J.M. Beerhuizen, R.J.A. Goris, H.J.M. Beijer, and G.A. Charbon . . . . .	495
<b>Vascular Perfusion of the Ischemic Small Intestine</b> Miklós Juhász, János Hamar, László Dézsi, Erzsébet Fehér, and Joachim Lutz . . . . .	503
<b>Reaction Pattern of Alveolar Cells in the Posttraumatic Lung Failure</b> Theo Joka, Udo Obertacke, Wolfgang Schönfeld, Susanne Oberste-Beulmann, Ulrich Pison, Ernst Kreuzfelder, Marianne Jochum, and Gerda Zilow . . . . .	509

<b>Phospholipid Lung Profile in Adult Respiratory Distress Syndrome— Evidence for Surfactant Abnormality</b>	
U. Pison, E. Gono, T. Joka, and U. Obertacke . . . . .	517
<b>Wound Inflammatory Mediators and Multisystem Organ Failure</b>	
Robert H. Demling . . . . .	525
<b>Burn Shock and Its Resuscitation</b>	
David N. Herndon, James G. Hilton, Daniel L. Traber, and Robert E. Barrow .	539
<b>3. THE HEART AS A SPECIAL TARGET ORGAN IN SHOCK</b>	
<b>Evaluation of Heart Performance With Special Emphasis on Severe Hemodynamic Changes During Hypovolemic-Traumatic Shock</b>	
Peter Krösl and Günther Schlag . . . . .	561
<b>Myocardial Dysfunction in Sepsis</b>	
John J. Spitzer, Lani W. Smith, Edmund C. Burke, and Kathleen H. McDonough . . . . .	573
<b>Studies on Low Molecular Weight Inotropic Plasma Substances in Prolonged Hypovolemic Traumatic Shock</b>	
Seth Hallström, Christa Vogl, Peter Krösl, Heinz Redl, and Günther Schlag . .	591
<b>Cardiodepressant and Cardiotonic Factors in Shock</b>	
Sandor Nagy . . . . .	599
<b>Release of Myocardial Depressant Factor (MDF) During Cardiopulmonary Bypass (CPB): Influence of Corticosteroids (Methylprednisolone) and Protease Inhibitor (Aprotinin)</b>	
Farag I. Coraim, Günther Laufer, Wilfried Ilias, Gregor Wollenek, and Ernst Wolner . . . . .	611
<b>Endogenous Nickel Release in Injured Patients: A Possible Cause of Myocardial Damage</b>	
Kornél Szabó, István Balogh, and Anna Gergely . . . . .	621
<b>Heart Rate During Hypotensive Central Hypovolemia Before and After Atropine in Man</b>	
Kåre Sander-Jensen, Jesper Mehlsen, Carsten Stædeager, Peter Bie, and Jørgen Warberg . . . . .	629
<b>Antioxidant Protection Against Free Radicals Mediated Myocardial Injury</b>	
Elizabeth Röth, Bela Török, William Bär, and Susan Pollak . . . . .	633
<b>Index</b> . . . . .	641





## Contributors

**Ansgar O. Aasen**, Surgical Department, Ullevaal Hospital, University of Oslo, 0407 Oslo 4, Norway [133,185,193,211,227]

**Svenerik Andreasson**, Department of Anesthesiology, East Hospital, Göteborg, Sweden [133]

**P. Angiolini**, Institute of Anesthesiology and Intensive Therapy, University Policlinico di Careggi, 50134 Florence, Italy [259]

**Frederick Aono**, Department of Life Sciences, Travenol Laboratories, Inc., Round Lake, IL 60073 [333]

**Soheyl Bahrami**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [347]

**István Balogh**, Institute of Forensic Medicine, Semmelweis Medical University, Budapest, Hungary 1082 [621]

**William Bär**, Material Chemical Works, Budapest, Hungary 1734 [633]

**Robert E. Barrow**, Department of Research, Shriners Burns Institute, Galveston, TX 77550 [539]

**Elizabeth Basalka**, Sandoz Forschungsinstitut, A-1235 Vienna, Austria [427]

**G. I. J. M. Beerthuisen**, Department of General Surgery, University Hospital St. Radboud, Nijmegen, The Netherlands [495]

**Kristina E-dr. Behm**, Clinical Research Center, University Hospital, Linköping, Sweden [63]

**H. J. M. Beijer**, Experimental Laboratory for Peripheral Circulation, University Hospital Utrecht, Utrecht, The Netherlands [495]

**Anders Bengtson**, Department of Anesthesiology, Sahlgren's Hospital, Göteborg, Sweden [3,11]

**Maj-Britt Bengtsson**, Clinical Research Center, University Hospital, Linköping, Sweden [63]

**M. Biasiucci**, Intensive Care Department, II Faculty of Medicine, University of Naples, Napoli, Italy [271]

**Peter Bie**, Department of Medical Physiology, Panum Institute and Hvidovre Hospital, University of Copenhagen, Copenhagen, Denmark [629]

**Serge Blécic**, Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Brussels, Belgium [393]

The numbers in brackets are the opening page numbers of the contributors' articles.

**Günther Blümel**, Department of Experimental Surgery, Technical University, 8000 Munich 80, Federal Republic of Germany [419]

**Roger C. Bone**, Rush-Presbyterian-St. Luke's Medical Center, Chicago, Illinois 60612 [327]

**Julian Borgia**, Department of Life Sciences, Travenol Laboratories, Inc., Round Lake, IL 60073 [333]

**Edmund C. Burke**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [573]

**Claude Celotto**, Institute of Biochemistry, University of Graz, A-8010 Graz, Austria [245]

**G. A. Charbon**, Experimental Laboratory for Peripheral Circulation, University Hospital Utrecht, Utrecht, The Netherlands [495]

**M. Cianciulli**, Intensive Care Department, II Faculty of Medicine, University of Naples, Napoli, Italy [271]

**C. Clasen**, Krankenhaus Itzehoe, 2210 Itzehoe, Federal Republic of Germany [175]

**C. G. Cochrane**, Research Institute of Scripps Clinic, San Diego, CA 92103 [253]

**Farag I. Coraim**, Department of Anaesthesiology and Intensive Care Medicine, The University of Vienna, Vienna A-1090, Austria [611]

**R. Cuocolo**, Intensive Care Department, II Faculty of Medicine, University of Naples, Napoli, Italy [271]

**Ion V. Deaciuc**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [401]

**Corinne De Boelpaep**, Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Brussels, Belgium [393]

**Robert H. Demling**, Longwood Area Trauma Center, Harvard Medical School, Boston, MA 02115 [525]

**Claudio Denzlinger**, Biochemisches Institut, University of Freiburg, D-7800 Freiburg, Federal Republic of Germany [301]

**László Dézsi**, Experimental Research Department, Semmelweis University Medical School, Budapest, Hungary [503]

**Hans P. Dinges**, Institute of Pathology, University of Graz, Graz, Austria [43]

**Heinrich Ditter**, Department of Internal Medicine, Justus-Liebig University, D-6300 Giessen, Federal Republic of Germany [369]

**Marc Domb**, Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Brussels, Belgium [393]

**Hermann Esterbauer**, Institute of Biochemistry, University of Graz, A-8010 Graz, Austria [245]

**Erzsébet Fehér**, Department of Anatomy, Semmelweis University Medical School, Budapest, Hungary [503]

**E. Fink**, Abteilung für Klinische Chemie und Klinische Biochemie, Chirurgische Klinik Innenstadt der Universität München, D-8000 München 2, Federal Republic of Germany [159]

**Keith N. Frayn**, MRC Trauma Unit, University of Manchester, Manchester M13 9PT, United Kingdom [463]

**H. Fritz**, Abteilung für Klinische Chemie und Klinische Biochemie, Chirurgische Klinik Innenstadt der Universität München, D-8000 München 2, Federal Republic of Germany [127]

**Günther Fuhrer**, Department of Thoracic and Cardiovascular Surgery, University of Tübingen, D-7400 Tübingen, Federal Republic of Germany [87, 107]

**Michael J. Gallimore**, Department of Thoracic and Cardiovascular Surgery, University of Tübingen, D-7400 Tübingen, Federal Republic of Germany [87]

**R. Geiger**, Abteilung für Klinische Chemie und Klinische Biochemie, Chirurgischen Klinik der Universität München, D-8000 München 2, Federal Republic of Germany [115]

**Alfred Geißler**, Institute for Experimental Medicine, University of Cologne, D-5000 Cologne, Federal Republic of Germany [95]

**Anna Gergely**, National Institute of Nutrition, Budapest, Hungary 1097 [621]

**Anders Gidlöf**, Clinical Research Center, University Hospital, Linköping, Sweden [63]

**E. Gono**, Abteilung Arbeitsmedizin, Medizinische Einrichtungen der Universität-Gesamthochschule Essen, Essen, Federal Republic of Germany [517]

**R. Jan. A. Goris**, Department of General Surgery, University Hospital St. Radboud, Nijmegen, The Netherlands [55, 495]

**A. B. Johan Groeneveld**, Department of Internal Medicine, Medical Intensive Care Unit, Free University Hospital, Amsterdam, The Netherlands [487]

**Wolfgang Hagmann**, Biochemisches Institut, University of Freiburg, D-7800 Freiburg, Federal Republic of Germany [301]

**Seth Hallström**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [591]

**János Hamar**, National Institute of Traumatology, Semmelweis University Medical School, Budapest, Hungary [503]

**Dale E. Hammerschmidt**, Hematology Division, Department of Medicine, University of Minnesota, Minneapolis, MN 55455 [19]

**Peter Heckenast**, Institute of Biochemistry, University of Graz, A-8010 Graz, Austria [245]

**Mats Heideman**, Department of Surgery I, Sahlgren's Hospital, Göteborg, Sweden [3,11]

**Wolfgang Heller**, Department of Thoracic and Cardiovascular Surgery, University of Tübingen, D-7400 Tübingen, Federal Republic of Germany [87, 107]

**David N. Herndon**, Department of Surgery, Shriners Burns Institute, Galveston, TX 77550 [539]

**James G. Hilton**, Department of Pharmacology, Shriners Burns Institute, Galveston, TX 77550 [539]

**D. B. Hinshaw**, Research Institute of Scripps Clinic, San Diego, CA 92103 [253]

**Susanne Hoberg**, Department of Thoracic and Cardiovascular Surgery, University of Tübingen, D-7400 Tübingen, Federal Republic of Germany [107]

**H. Hoffmann**, Abteilung für Klinische Chemie und Klinische Biochemie, Chirurgische Klinik Innenstadt der Universität München, D-8000 München 2, Federal Republic of Germany [115,127,159]

**Hans-Eberhard Hoffmeister**, Department of Thoracic and Cardiovascular Surgery, University of Tübingen, D-7400 Tübingen, Federal Republic of Germany [87,107]

**Pia Holmberg**, Department of Anesthesiology, Sahlgren's Hospital, Göteborg, Sweden [11]

**Geza Horpacsy**, Institute for Experimental Medicine, University of Cologne, D-5000 Cologne, Federal Republic of Germany [95]

**Werner Hügel**, Institute for Experimental Medicine, University of Cologne, D-5000 Cologne, Federal Republic of Germany [95]

**P. A. Hyslop**, Research Institute of Scripps Clinic, San Diego, CA 92103 [253]

**Wilfried Ilias**, Second Surgical Department, The University of Vienna, Vienna, Austria [611]

**Elizabeth Rogers Jacobs**, University of Arkansas for Medical Sciences, Little Rock, AR 72205; present address: Rush-Presbyterian-St. Luke's Medical Center, Chicago, IL 60612 [327]

**Gary J. Jesmok**, Department of Life Sciences, Travenol Laboratories, Inc., Round Lake, IL 60073 [333]

**Marianne Jochum**, Abteilung für Klinische Chemie und Biochemie, Chirurgischen Klinik Innenstadt der Universität München, D-8000 München 2, Federal Republic of Germany [121,175,509]

**Theo Joka**, Abteilung Unfallchirurgie, Medizinische Einrichtungen der Universität-Gesamthochschule Essen, Essen, Federal Republic of Germany [311,509,517]

**Miklós Juhász**, O. Korvin Hospital, 1071 Budapest, Hungary [503]

**Dietrich Keppler**, Biochemisches Institut, University of Freiburg, D-7800 Freiburg, Federal Republic of Germany [301]

**J. Knöller**, Institut für Medizinische, Mikrobiologie und Immunologie, Bochum, Federal Republic of Germany [311]

**Ernst Koller**, Institute of Biochemistry, University of Graz, A-8010 Graz, Austria [245]

**W. König**, Institut für Medizinische, Mikrobiologie und Immunologie, Bochum, Federal Republic of Germany [311,317]

**K.-H. Konz**, Medizinische Klinik, Abteilung Kardiologie, University of Tübingen, Tübingen, Federal Republic of Germany [281]

**Ernst Kreuzfelder**, Medizinische Virologie und Immunologie, Universitätsklinikum Essen, Essen, Federal Republic of Germany [509]

**Peter Krösl**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [561,591]

**Karel Kubat**, Department of Pathology, University Hospital St. Radboud, Nijmegen, The Netherlands [55]

**Charles Lam**, Sandoz Forschungsinstitut, A-1235 Vienna, Austria [427]

**Dagmar Langner**, Department of Experimental Surgery, Technical University, 8000 Munich 80, Federal Republic of Germany [419]

**Günther Laufer**, Second Surgical Department, The University of Vienna, Vienna A-1090, Austria [611]

**David H. Lewis**, Clinical Research Center, University Hospital, Linköping, Sweden [63]

**Rod A. Little**, MRC Trauma Unit, University of Manchester, Manchester M13 9PT, United Kingdom [463]

**Joachim Lutz**, Department of Physiology, University of Würzburg, Würzburg, Federal Republic of Germany [503]

**Pascal Luybaert**, Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Brussels, Belgium [393]

**Asrar B. Malik**, Department of Physiology, Albany Medical College of Union University, Albany, NY 12208 [33]

**G. Martini**, Institute of Anesthesiology and Intensive Therapy, University Policlinico di Careggi, 50134 Florence, Italy [259]

**F. Reinhard Matthias**, Department of Internal Medicine, Justus-Liebig University, D-6300 Giessen, Federal Republic of Germany [369]

**Kathleen H. McDonough**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [573]

**Jesper Mehlsen**, Department of Medical Physiology, Panum Institute and Hvidovre Hospital, University of Copenhagen, Copenhagen, Denmark [629]

**Angela Menschik**, Cardiovascular Research Laboratories, AB Hässle, Mölndal, Sweden [63]

**Fred Mihm**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [347]

**K. M. Moser**, University of California Medical Center, San Diego, CA 92103 [203]

**Robert Moser**, Institute of Biochemistry, University of Graz, A-8010 Graz, Austria [245]

**W. Mueller-Esterl**, Abteilung für Klinische Chemie und Klinische Biochemie, Chirurgische Klinik Innenstadt, Universität München, 8000 München 2, Federal Republic of Germany [175]

**Hugo Müller**, Institute for Experimental Medicine, University of Cologne, D-5000 Cologne, Federal Republic of Germany [95]

**Froye Naess**, Surgical Department, Ullevaal Hospital, University of Oslo, Oslo, Norway [185]

**Sandor Nagy**, Institute of Experimental Surgery, University Medical School of Szeged, Szeged, Hungary [599]

**Heinz Neuhof**, Department of Internal Medicine, Division of Clinical Pathophysiology and Experimental Medicine, Justus Liebig University, 6300 Giessen, Federal Republic of Germany [289]

**G. P. Novelli**, Institute of Anesthesiology and Intensive Therapy, University Policlinico di Careggi, 50134 Florence, Italy [259]

**Hans K.S. Nuytinck**, Department of General Surgery, University Hospital St. Radboud, Nijmegen, The Netherlands [55]

**Susanne Oberste-Beulmann**, Unfallchirurgie, Universitätsklinikum Essen, Essen, Federal Republic of Germany [509]

**Udo Obertacke**, Abteilung Unfallchirurgie, Medizinische Einrichtungen der Universität-Gesamthochschule Essen, Essen, Federal Republic of Germany [509,517]

**Xavier J.M.W. Offermans**, Department of General Surgery, University Hospital St. Radboud, Nijmegen, The Netherlands [55]

**O. Ortolani**, Intensive Care Department, II Faculty of Medicine, University of Naples, Napoli, Italy [271]

**Eva Paul**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [165]

**Anton Philipitsch**, Immuno Hämoderivate AG, A-1220 Wien, Austria and Department of Thoracic and Cardiovascular Surgery, University of Tübingen, D-7400 Tübingen, Federal Republic of Germany [107,141,159]

**Johan Pillgram-Larsen**, Surgical Department, Ullevaal Hospital, University of Oslo, 0407 Oslo 4, Norway [185,193,211,227]

**Ulrich Pison**, Abteilung Unfallchirurgie, Medizinische Einrichtungen der Universität-Gesamthochschule Essen, Essen, Federal Republic of Germany [317,509,517]

**Susan Pollak**, Material Chemical Works, Budapest, Hungary 1743 [633]

**Heinz Redl**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [xxv,43,165,347,591]

**Hubert Reichle**, Department of Anaesthesiology, University of Munich, 8000 Munich 70, Federal Republic of Germany [419]

**Bo Risberg**, Department of Surgery I, Sahlgrenska Hospital, Göteborg, Sweden [133]

**Bryan L. Roth**, Naval Medical Research Institute, Bethesda, MD 20814 [401]

**Elizabeth Röth**, Department of Experimental Surgery, University of Medicine, Pécs, Hungary 7643 [633]

**Peter Röttger**, Department of Pathology, General Hospital, D-5160 Düren, Federal Republic of Germany [369]

**Tom E. Ruud**, Surgical Department, Ullevaal Hospital, University of Oslo, 0407 Oslo 4, Norway [185,193,211,227]

**Kåre Sander-Jensen**, Department of Medical Physiology, Panum Institute and Hvidovre Hospital, University of Copenhagen, Copenhagen, Denmark [629]

**Anna Schiesser**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [165,347]

**Günther Schlag**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [xxv,43,165,347,561,591]

**K. P. Schmit-Neuerburg**, Abteilung Unfallchirurgie, Medizinische K.P. Schmit-Neuerburg, Abteilung Einrichtungen der Universität-Gesamthochschule, Essen, Federal Republic of Germany [317]

**Wolfgang Schönfeld**, Institut Für Medizinische Mikrobiologie und Immunologie, Universität Bochum, Bochum, Federal Republic of Germany [311,509]

**I. U. Schraufstatter**, Research Institute of Scripps Clinic, San Diego, CA 92103 [253]

**Hans-Peter Schuster**, Medizinische Klinik I, Städtisches Krankenhaus Hildesheim, D-3200 Hildesheim, Federal Republic of Germany [459]

**Eberhard Schütze**, Sandoz Forschungsinstitut, A-1235 Vienna, Austria [427]

**Werner Seeger**, Department of Internal Medicine, Division of Clinical Pathophysiology and Experimental Medicine, Justus Liebig University, 6300 Giessen, Federal Republic of Germany [289]

**P. Sefrin**, Institute of Anaesthesiology, University of Würzburg, D-8700 Würzburg, Federal Republic of Germany [477]

**William C. Shoemaker**, Department of Surgery, Los Angeles County King-Drew Medical Center, University of California, Los Angeles, Los Angeles, CA 90059 [361]

**M. Siebeck**, Chirurgische Klinik Innenstadt, Universität München, D-8000 München 2, Federal Republic of Germany [115,121,127,141,159]

**John H. Siegel**, Department of Surgery Johns Hopkins University and Department of Surgery, Maryland Institute for Emergency Medical Services Systems, University of Maryland, Baltimore, MD 21201 [439]

**Janet Simpson**, Department of Life Sciences, Travenol Laboratories, Inc., Round Lake, IL 60073 [333]

**Lani W. Smith**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [573]

**Lennart Smith**, Department of Surgery I, Sahlgrenska Hospital, Göteborg, Sweden [133]

**R. M. Smith**, University of California Medical Center, San Diego, CA 92103 [203]

**John J. Spitzer**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [573]

**Judy A. Spitzer**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [401]

**R. G. Spragg**, University of California Medical Center, San Diego, CA 92103 [203, 253]

**Jan. O. Stadaas**, Surgical Department, Ullevaal Hospital, University of Oslo, 0407 Oslo 4, Norway [185,193, 211, 227]

**Carsten Stadeager**, Department of Medical Physiology, Panum Institute and Hvidovre Hospital, University of Copenhagen, Copenhagen, Denmark [629]

**J. Sturm**, Medizinische Hochschule Hannover, Hannover, Federal Republic of Germany [311]

**Norbert Suttorp**, Department of Internal Medicine, Division of Clinical Pathophysiology and Experimental Medicine, Justus-Liebig University, 6300 Giessen, Federal Republic of Germany [289]

**Kornél Szabó**, Burn Center, Central Hospital, Budapest, Hungary 1553 [621]

**R. Tani**, Institute of Anesthesiology and Intensive Therapy, University Policlinico di Careggi, 50134 Florence, Italy [259]

**O. Thetter**, Chirurgische Klinik Innenstadt, Universität München, D-8000 München 2, Federal Republic of Germany [121,127,159]

**Lambertus G. Thijs**, Department of Internal Medicine, Medical Intensive Care Unit, Free University Hospital, Amsterdam, The Netherlands [487]

**Martin Thurnher**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [347]

**G. Tiegs**, Physiologisch-Chemisches Institut, University of Tübingen, Tübingen, Federal Republic of Germany [281]

**Gerd O. Till**, Department of Pathology, University of Michigan Medical School, Ann Arbor, MI 48109 [235]

**Bela Török**, Department of Experimental Surgery, University of Medicine, Pécs, Hungary 7643 [633]

**Daniel L. Traber**, Department of Anesthesiology and Physiology, University of Texas Medical Branch; and Department of Anesthesia Research, Shriners Burn Institute, Galveston, TX 77550 [149,377,539]

**A. Trebbi**, Intensive Care Department, II Faculty of Medicine, University of Naples, Napoli, Italy [271]

**Elena R. Turco**, Department of Physiology, Louisiana State University Medical Center, New Orleans, LA 70112 [401]

**Philippe Van der Linden**, Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Brussels, Belgium [393]

**Gregory M. Vercellotti**, Hematology Division, Department of Medicine, University of Minnesota, Minneapolis, MN 55455 [19]

**Jean-Louis Vincent**, Department of Intensive Care, Erasme University Hospital, Free University of Brussels, Brussels, Belgium [393]

**Christa Vogl**, Ludwig Boltzmann Institute for Experimental Traumatology, Vienna, Austria [347,591]

**Reinhard Voss**, Department of Internal Medicine, Justus-Liebig University, D-6300 Giessen, Federal Republic of Germany [369]

**Hubert Walzl**, Sandoz Forschungsinstitut, A-1235 Vienna, Austria [427]

**Jørgen Warberg**, Department of Medical Physiology, Panum Institute and Hvidovre Hospital, University of Copenhagen, Copenhagen, Denmark [629]

**Peter A. Ward**, Department of Pathology, University of Michigan Medical School, Ann Arbor, MI 48109 [235]

**H. F. Welter**, Chirurgische Klinik Innenstadt, Universität München, D-8000 München 2, Federal Republic of Germany [121,127,141]

**A. Wendel**, Physiologisch-Chemisches Institut, University of Tübingen, Tübingen, Federal Republic of Germany [281]

**Peter Wendt**, Department of Experimental Surgery, Technical University, 8000 Munich 80, Federal Republic of Germany [419]

**Stephen Westaby**, Royal Postgraduate Medical School, Hammersmith Hospital, London, UK [75]



**H. Wiesinger**, Pathologisches Institut,  
Universität München, D-8000 München  
2, Federal Republic of Germany [141]

**Claudia Wilfing**, Ludwig Boltzmann  
Institute for Experimental  
Traumatology, Vienna, Austria [165]

**Frank J. Wilson, Jr.**, University of  
Oklahoma Health Sciences Center,  
Oklahoma City, OK 73104 [327]

**Gregor Wollenek**, Second Surgical  
Department, The University of Vienna,  
Vienna A-1090, Austria [611]

**Ernst Wolner**, Second Surgical  
Department, The University of Vienna,  
Vienna A-1090, Austria [611]

**Gerda Zilow**, Department of  
Immunologie, Universität Heidelberg,  
Heidelberg, Federal Republic of  
Germany [509]



# Contents of Part B: Monitoring and Treatment of Shock

## 1. MONITORING OF SHOCK

### 1.1. Prognostic Indices and Scoring

**Scoring Systems and Predictors of ARDS and MOF** / R. Jan A. Goris, Hans K.S. Nuytinck, and Heinz Redl

**The Use of Scoring Systems as Prognostic Parameter After Surgery and Trauma** / Peter Lehmkuhl, M. Ludwig, and I. Pichlmayr

**Prediction of Outcome in Sepsis** / H.B. Stoner

**Prognostic Indices in Septic Shock** / Jesús Villar, Miguel A. Blazquez, José A. Bolaños, Juan J. Manzano, and José Quintana

### 1.2. Biochemical Parameters

**Quantification of Granulocyte Enzymes/Proteins With Immunoassays** / H. Lang, S. Neumann, W. Rautenberg, H. Fritz, Marianne Jochum, and D. Inthorn

**Studies of Granulocyte Function (Chemiluminescence Response) in Postoperative Infection** / Dietrich Inthorn, Thomas Szczeponik, Dieter Mühlbayer, Marianne Jochum, and Heinz Redl

**Elevated D-erythro-Neopterin Levels in Intensive Care Patients With Septic Complications** / Wolfgang Strohmaier, Heinz Redl, Günther Schlag, and Dietrich Inthorn

**The Influence of Septic Shock on Plasma Proteins, Lymphocytes and Metabolic Parameters** / Erich Roth, Rudolf Steininger, Ingrid Schindler, Gerhard Hamilton, Walter Mauritz, Friedrich Zekert, Manfred Mattausch, Eva Schönthal, Paul Sporn, and Josef Funovics

**Inhibition of Beta-FXIIa in Plasma of Volunteers and Polytraumatized Patients** / Günther Fuhrer, Michael J. Gallimore, Wolfgang Heller, and Hans-Eberhard Hoffmeister

**Can the Outcome After Trauma of Sepsis be Predicted From Biochemical or Hormonal Parameters?** / Thomas Pasch, Jörg Mahlstedt, Josef Pichl, Gernot Buheitel, and Edgar Pscheidl

**The Proenzyme Functional Inhibition Index as a Predictor in Septicemia** / Ansgar O. Aasen

### 1.3. Hemodynamic Parameters

**Physiologic Monitoring and Therapy of High Risk Surgical Patients** / William C. Shoemaker

**Hämodynamic Pattern in Septic Peritonitis** / Heinz Köhler, W. Reichow, J. Martell, G. Köveker, and A. Schafmayer

**Early Metabolic and Vascular Tone Patterns in Lethal Sepsis** / Ivo Giovannini, Giuseppe Boldrini, Carlo Chiarla, Marco Castagneto, and Giancarlo Castiglioni

**Judgement of Central Haemodynamics With and Without Swan Ganz Catheter in Septic Shock States** / Gerhard Redl, Ernst Zadrobilek, Ingrid Schindler, Walter Mauritz, and Paul Sporn

**Hemodynamic Characterization of Sepsis** / K. Lenz, A. Laggner, W. Druml, G. Graninger, G. Grimm, and B. Schneeweiß

### 1.4. Extravascular Lung Water

**Intravascular Starling Forces and Extravascular Lung Water in Advanced Septic Shock States** / Ernst Zadrobilek, Ingrid Schindler, Gerhard Redl, Walter Mauritz, Hermann Gilly, Paul Sporn, and Karl Steinbereithner

**Dynamics of Extravascular Lung Water in Major Burns** / Anton N. Laggner, Kurt Lenz, Gernot Sommer, Wilfried Druml, Bruno Schneeweisz, Georg Grimm, and Gunter Kleinberger

**Extravascular Lung Water and Pulmonary Artery Pressure With Acute Respiratory Failure—Effect of Ketanserin Administration** / W. Heinrichs, U. Fauth, and M. Halmágyi

## **2. TREATMENT OF SHOCK**

### **2.1. Basic Supportive Therapy**

**Prevention of ARDS and MOF by Prophylactic Mechanical Ventilation and Early Fracture Stabilisation** / R.J.A. Goris

**Modern Strategies of Ventilatory Management in Shock** / H. Benzer, M. Baum, J. Koller, W. Koller, G. Kroesen, and N. Mutz

**Therapeutic Approaches: Haemodynamic and Respiratory Complications in Septic Shock** / P. Lawin, H.J. Lübbesmeyer, M. Möllmann, N. Mertes, and H. Van Aken

### **2.2. Volume Replacement**

**Fluid Resuscitation in Canine Traumatic-Hemorrhagic Shock: Long-Term Comparison of Hydroxyethyl Starch vs. Ringer's Lactate** / Uwe B. Brückner, Michael Albrecht, Lorenz Frey, and Lars-G. Hein

**Treatment of Experimental Mesenteric Shock by Different Fluids** / János Hamar, Joachim Lutz, László Dézsi, and Miklós Juhász

**Does Isovolemic Hemodilution Predispose to Infection?** / Wolfgang Graninger, Franz X. Lackner, Reswan Khosropour, Christine Hlozaneck, and Robert Kurz

### **2.3. Plasmapheresis and Hemofiltration**

**Plasma Exchange in Septic Shock** / Lars J. Bjertnaes

**Continuous Pump Driven Hemofiltration (CPDHF) in Septic Renal Failure** / Paul Sporn, Walter Mauritz, Gerhard Redl, Ingrid Schindler, Karl Steinbereithner, and Ernst Zadrobilek

**Continuous Arterio-Venous Hemofiltration for the Treatment of Acute Renal Failure in Septic Shock** / Wolfgang Reichow, Heinz Koehler, Klaus Dietrich, and Anton Schafmayer

**The Continuous Arterio-Venous Hemofiltration in Shock** / H.C. Rau, K.H. Staubach, C. Hohlbach, and W. Klingler

### **2.4. Corticosteroids**

**Corticosteroids in the Treatment of Septic Shock** / William Schumer

**Effect of Methylprednisolone, Prednisolone and Dexamethasone on Granulocyte Function and Complement Activation** / Heinz Redl, Herbert Lamche, Eva Paul, Anna Schiesser, and Günther Schlag

**Comparison of Different Corticosteroids in Rat Endotoxemia** / Soheyl Bahrami, Anna Schiesser, Heinz Redl, and Günther Schlag

**Can Preoperative High Dose Corticosteroids Preserve Normal Pulmonary Permeability and Homeostasis?** / Lennart Smith, Sven Erik Andreasson, Tom Saldeen, and Bo Risberg

### **2.5 Specific Measures**

**Influence of Parenteral Nutrition on Lung Surfactant in the Traumatized Rat** / Soheyl Bahrami, Harald Gasser, Wolfgang Strohmaier, Heinz Redl, and Günther Schlag

**Effects of Surfactant Replacement on Respiratory Failure Induced by Free Oxygen Radicals** / B. Lachmann, O.D. Saugstad, and W. Erdmann

**Glucose-Insulin-Potassium (GIK) in Hypodynamic Septic Shock** / Walter Mauritz, Ingrid Schindler, Ernst Zadrobilek, and Paul Sporn

**Non-Adrenergic Intropic Support in Septic Shock** / Marc Domb, Corinne De Boelpeape, and Jean-Louis Vincent

**Effects of Endotoxin and Gadolinium Chloride on Acute Septic Peritonitis and Septic Shock in Rats** / George Lázár, Jr., Elizabeth Huszti, and George Lázár

## REACTION PATTERN OF ALVEOLAR CELLS IN THE POSTTRAUMATIC LUNG FAILURE\*

Theo Joka<sup>1</sup>, Udo Obertacke<sup>1</sup>, Wolfgang Schönfeld<sup>3</sup>,  
Susanne Oberste-Beulmann<sup>1</sup>, Ulrich Pison<sup>1</sup>,  
Ernst Kreuzfelder<sup>2</sup>, Marianne Jochum<sup>4</sup>,  
Gerda Zilow<sup>5</sup>

Abteilung für:

1. Unfallchirurgie, Universitätsklinikum Essen, FRG
2. Med. Virologie und Immunologie, Universitätsklinikum Essen, FRG
3. Med. Mikrobiologie und Immunologie, Universität Bochum, FRG
4. Klinische Chemie und Biochemie, Universität München, FRG
5. Immunologie, Universität Heidelberg, FRG

### INTRODUCTION

The acute respiratory distress syndrome (ARDS) is still one of the life threatening organic complications which might occur as a consequence of pulmonary and extrapulmonary diseases like e.g. sepsis, polytrauma, burns or shock. It is caused by an initial disturbance of the capillary and alveolar barrier function (HAMMERSCHMIDT et al. 1980) which later is followed by a proliferative parenchyma (BLEYL 1979). The broncho-alveolar lavage (BAL) can be used as a diagnostic tool to detect early cellular and humeral alterations in ARDS (HUNNINGHAKE et al. 1979, JOKA et al. 1985). This is independent of the etiology of the immunologic process.

Our scientific interest is focussed on the following questions:

1. to determine the extent and limitation of the capillary and alveolar barrier dysfunction.
2. To investigate the interdependent interaction of pathogenetic factors based on the alveolar cell response

\* This work was supported by the "Deutsche Forschungsgemeinschaft" project II B 6.

## METHODS AND MATERIALS

In multi injured patients with uniform initial criteria (PTS) (OESTERN et al. 1985) clinical progress (cardio pulmonary monitoring) (LEWIS et al. 1979) was compared with biochemical parameters in serum and BAL. The following factors were determined: complement fragments, intracellular marker-enzymes (Elastase, Myeloperoxidase, Laktoferrine, Alpha-1-PI, LDH, etc.) leukotrienes and further selected proteins. The oxidation potential as an indirect measure of the cell activity was determined by the luminol-enhanced chemoluminescence (WILLIAMS et al. 1981, CHENUNG et al. 1983).

## RESULTS

19 polyinjured patients have been examined prospectively. The severity of trauma has been defined by the common initial trauma score (PTS 30 points). BAL has always been performed under the same conditions immediately after the trauma and once per day. However to investigate the pathomechanism of the ARDS it is necessary to define this failure on clinical criteria. In our studies the extravascular lung water (ELVW) was the most essential criterion to detect capillary leakage. In addition patients were divided in group with (group AB) or without (group CD) increase of lung water to evaluate the measured clinical and biochemical parameters respectively. This was based on the experience that an ELVW exceeding 10 ml/kg KG leads to significant respiratory alterations associated with ARDS. The wedge-pressure served as an expression for an insufficiency of the left heart to exclude left ventricular failure. The same difference in regard to the alveolo-arterial oxygen pressure difference (AaDO<sub>2</sub>), the oxygenation quotient and the dynamic compliance were seen for the ARDS/non-ARDS group. The accompanying pulmonary vascular hypertension in case of ARDS was evidenced by the progress of the mean pulmonary artery pressure. However the increase of lung water above 10 ml/kg KG occurred before the alterations of respiratory and hemodynamic values. 40 % of the ARDS-group (n=5) died as a result of a respiratory failure, whereas the mortality in the group without increase of the lung water (n=14) was only 11 %.

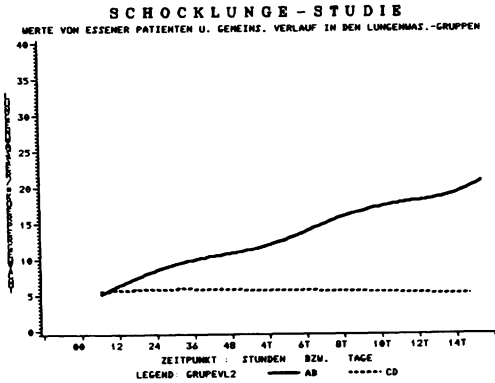


Figure 1. Cours of extravascular lung water group AB (ARDS) compared to group CD (non-ARDS). Statistically evaluated by C.REINSCH 1969

Plasmatic and cytobiological alterations were classified in the same way. The influx of neutrophiles into the alveolar unit was in accordance with data described in the literature (TATE et al. 1983). In the group without ARDS normal inflammatory response of the cells was seen. This was suggested by data found in the chemoluminescence-assay with purified alveolar neutrophiles (high PEAK, short PEAK-time). Alveolar neutrophiles of patients with ARDS were characterized by low PEAK and long PEAK-time during the chemoluminescence response. Similar results were obtained for blood as well as alveolar neutrophiles in one patient. In this case the release of LTB<sub>4</sub> was inhibited.

The alveolar influx of granulocytes was associated with an intraalveolar increase of elastase. Elastase-Proteinase-inhibitor complex was comparatively higher in BAL than in plasma. In addition the amount of this complex in BAL correlated with the severity of the lung failure. The enzymatic activity of elastase could only be detected in severe cases.

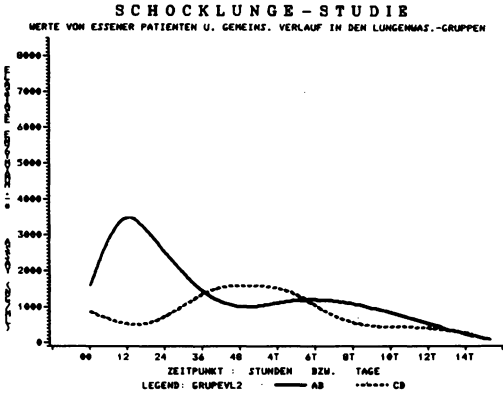


Figure 2. Concentrations of Elastase-Proteinase-inhibitor complex in BAL of patients with and without lung water increase (group AB/CD).

High concentration of leukotrienes could be measured in the ARDS-group during the first hours after trauma.

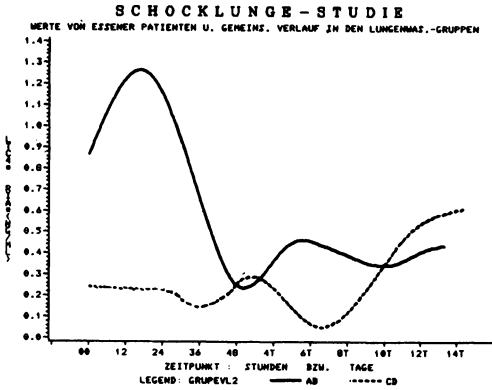


Figure 3. Courses of the leukotriene in BAL based on clinical classification (group AB/CD)

Significant differences were found in C3A during the first four days. C3A occurs one day before granulocytes influx.

A further chemotactic stimulus could be originated from the intraalveolar proteolytic potential. In contrast to



blood, we found an overall increase of total protein in ARDS-group during the onset of ARDS. Up to the 4th day all proteins in lavage were significantly increased. Two different types of proteins were found in the lavage fluid: those of vascular origin (Albumin, Alpha-1-Proteinase-Inhibitor, Alpha-2-Makroglobulin) as well as those of cellular origin from invading mobile cells (LDH, Elastase etc.).

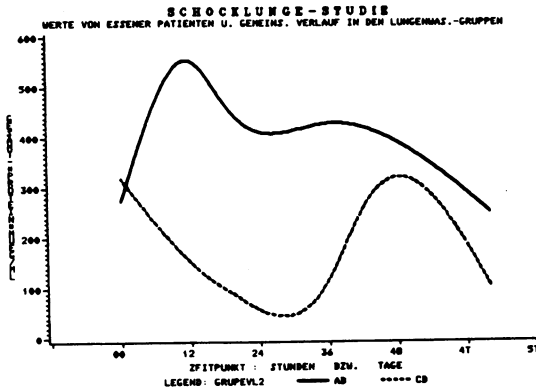


Figure 4. Courses of broncho-alveolar lavage Total Protein based on clinical classification (group AB/CD).

High amounts of IGG (above 3,5 mg/dl) and IGA during the first hours after trauma are commonly associated with an increase of the lung water at the 4th day. The intraalveolar presence of myoglobin strongly suggested an capillary leakage. In patients without ARDS (group CD) serum specific proteins or macro-proteins were undetectable after 36 hours.

## DISCUSSION

The alveolar capillary unit can be damaged by many inflammatory active mediators. This damage causes the process of inflammation. Its cardinal symptoms are edema and transmigration of neutrophiles. We could describe the intraalveolar cell influx. A group specific response pattern of alveolar neutrophiles was demonstrated in luminol-enhanced chemoluminescence. During the onset of ARDS an enhanced level of intracellular enzymes (COCHRANE et al. 1983) was associated with a bad cell response. The latter could be due either to a downregulation of the tested cells, as was suggested for several mediator-cell interactions, or to

cell death. In any case the breakdown of the physiologic regulation systems in alveolar capillary unit is the pathophysiologic background of progressive lung failure. We assumed that the extravasation of proteins and the intraalveolar release of proteolytic potentials (PARSON et al.1985) served as a "second stimulus" for lung damage. This would be an explanation for the decisive increase of lung water occuring four days after trauma. In addition the influx of protein may be the reason for a direct surfactant damage or a fault in surfactant phospholipid synthesis. This leads to the complete ARDS (PISON et al. 1986)

## REFERENCES

- BLEYL, U. (1979). Die Histophysiologie und Histopathologie der terminalen Lungenstrombahn bei akutem Lungenversagen. Klin. Anaesth. Intensivmedizin Band 20
- CHENUNG, K., ARCHIBALD, A.C., ROBINSON, M.F. (1983). The origin of Chemoluminescence produced by neutrophils stimulated by opsonized Zymosan. *J. of Immunol.* 130: 2324-2329
- COCHRANE, C.G., SPRAGG, R.G., REVAK, S.D., COHEN, A.B., Mc GUIRE, W.W. (1983). The presence of neutrophile. Elastase and evidence of oxydation activity in bronchoalveolar fluid of patients with ARDS. *Am. Rev. Resp. Dis.* 127: 25
- HAMMERSCHMIDT, D.E., WEAVER, L.J., HUDSON, L.D. (1980). Association of complement activation and elevated plasma C5A with ARDS: Pathophysiologic relevance and possible prognostic value. *Lancet* 1: 947
- HUNNINGHAKE, G.W., GADEK, J.E., KAWANAMI, O., FERRAUS, V.J., CRYSTAL, R.G. (1979). Inflammatory and immune processes in the human lung in health and disease: Evaluation by BAL. *Am. J. Pathol.* 79: 149
- JOKA, Th., OBERTACKE, U., PISON, U., NEUDECK, F., KEINECKE, K.O. (1985). Die BAL als Diagnostikum in der Intensivtherapie. *Anaesthesie, Intensivtherapie, Notfallmedizin* 20: 79-83
- LEWIS, F.R., ELINGS, V.B., STURM, J.A. (1979). Bedside measurement of lung water. *J. Surg. Res.* 27: 250

- OESTERN, H.J., TSCHERNE, H., STURM, J., NERLICH, M. (1985)  
Klassifizierung der Verletzungsschwere. Unfallchirurg  
88: 465-472
- PARSONS, P.E., FOWLER, A.A., HYERS, T.M., HANSON, P.M. (1985)  
Chemotactic activity in broncho-alveolar fluid from  
patients with ARDS. Am. Rev. Resp. Dis. 132: 490
- PISON, U., GONO, E., JOKA, Th., OBERTACKER, U., OBLADEN, M.  
(1986). High pressure liquid chromatography of adult  
human broncho-alveolar lavage - detection of phospho-  
lipid lung profile. J. of Chromatography in print.
- REINSCH, C. (1967). Smoothing Spline function. Numerische  
Mathematik Band 10: 177-182
- TATE, R.M., REGIME, D.E. (1983). Neutrophils and adult  
respiratory distress syndrome. Am. Rev. of Resp. Dis.  
135: 552
- WILLIAMS, A.J., COLE, P.J. (1981). Human broncho-alveolar  
lavage cells and luminol dependent Chemoluminescence.  
J. Clin. Pathol. 34: 167-171



## Index

- A23187 calcium ionophore, 290, 314, 315  
Acidosis, cardiodepressant, 600  
ADP-iron, cytotoxic lipid peroxidation products, rat liver microsomes, 247-249  
Adrenal gland, catecholamines, multiple trauma, and ARDS, 479  
Adrenaline. *See* Epinephrine  
 $\alpha_1$ -Adrenergic receptors, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 406-407, 415  
 $\beta$ -Adrenergic stimulation, myocardial dysfunction in sepsis, 576-577  
  isoproterenol, 577, 578  
Albumin flux, microvascular permeability, septic shock, 490-491  
Aldehydes, lipid peroxidation products, rat liver microsomes, 245-249; *see also* Malondialdehyde (MDA)  
Alveolar cell reactions, posttraumatic lung failure and ARDS, 509-514  
  AaDO<sub>2</sub>, 510  
  bronchoalveolar lavage, 509-513  
  chemiluminescence of neutrophils, 510, 511  
  complement, 510, 512  
  elastase, 510-513  
    *cf.* vascular proteins, 513  
  extravascular lung water, 510-512  
  leukotrienes, 510-512  
  polytrauma score, 510  
  *see also* Bronchoalveolar lavage  
Alveolar cells, type II, 103  
Alveolar hypoxia, arachidonic acid system activation, isolated lung, 294-295  
 $\alpha$ -Amanitin, 302, 306, 307  
Amylase, aprotinin and C1 esterase inhibitor infusion and pancreatic shock, pig, 195  
Anaphylatoxins (C3a and C5a). *See under* Complement activation  
Angiotensin II, 382, 402  
  heart stimulation, 599-600, 603-607  
Antihistamines, multitherapy regimen for endotoxemia, pigs, 212, 213, 222, 228  
Antioxidant drugs in shock therapy, 271-279  
  ascorbic acid, 276  
  BHT, 276  
  *vs.* granulocyte aggregation, 276-277  
  iron role, 272  
  lipid peroxidation, 274-275  
  *vs.* malondialdehyde formation, 276, 278  
   $\alpha$ -MPG, 276  
  natural systems, 272  
    loss in shock, 273-275  
  propyl-gallate, 276  
   $\alpha$ -tocopherol, 276  
  *see also* Oxygen free radical scavengers, prophylaxis and treatment of experimental shock, rat  
Antioxidant protection *vs.* free radical mediated myocardial injury, dogs, 633-639  
  ECG, 635  
  GSH, 635-639  
  ischemia-reperfusion, 634-639  
  lipid peroxidation, 633-635, 638-639  
    MDA, 635-636  
  MTDQ-DA, 633, 636, 639  
  SOD, 635-639  
Antiplasmin  
  multitherapy regimen for endotoxemia, pigs, 216, 219  
   $\alpha_2$ -, very high dosage aprotinin in polytrauma, 177, 180  
Antiproteases. *See* Protease inhibitors in endotoxemia; specific inhibitors  
Antithrombin III, 40  
  C1-esterase inhibitor  
    early *E. coli* septicemia, pigs, 142, 144  
    and elastase release, extracorporeal circulation, 108, 111

- eglin, elastase inhibitor, and lung edema, septic pigs, 122–124
- kallikrein-kinin system activation, lung, *E. coli* septic sheep, 134, 136–138
- multitherapy regimen for endotoxemia, pigs, 212, 213, 216, 217, 220, 221, 228
- $\alpha_1$ -Antitrypsin, C1-esterase inhibitor, early *E. coli* septicemia, pigs, 144
- Aortic endothelium, oxidant injury, cultured cells, 254–255
- Aorto-coronary bypass. *See* Cardio-pulmonary bypass
- Apnoe, extracorporeal circulation, biochemical lung monitoring during CPB, 96, 98–100, 103–104
- Apple II, 568
- Aprotinin
  - and kallikrein
    - activation, and C1-esterase inhibitor, 159–163
    - activation during CPB, 87–89, 91, 93
    - infused, kinin-induced pathology in ARDS development, pig, 127–130
    - MDF release during CPB, 611–615, 617–618
    - multitherapy regimen for endotoxemia, pigs, 212, 218, 220, 228
- Aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig 193–200
  - amylase, 195
  - hemodynamics, improved, 193
    - arterial pressure, 193, 195
    - cardiac output, 194–195
  - kallikrein, 194, 196–200
    - inhibition, 193–197, 199
  - kinin, 199
  - kininogen, 199
  - prekallikrein, 194, 196, 199, 200
  - survival rate, 193
- Aprotinin, cellular effects, 165–171
  - granulocyte function, 165–168, 170–171
    - elastase release, 166–169
  - phagocytosis, 169, 171
  - platelets, 165, 170, 171
  - superoxide radical, 165, 166, 169
  - SOD, 166
- Aprotinin, very high dosage, polytrauma, 175–182
  - $\alpha_2$ -antiplasmin, rocket immunoelectrophoresis, 177, 180
  - feasibility study, 176
  - infusion, 176–178, 181
  - kallikrein inhibition, 175–181
    - lung function, 180, 182
    - plasma levels, 178–181
    - plasmin inhibition, 179
    - renal function, 180–182
      - creatinine, 181
      - urine output, 180–181
    - tolerance, 182
- Aptoglobin, 272
- Arachidonic acid, 170, 260, 302, 305–307
  - ibuprofen and ETX-stimulated inflammation, 334, 342, 344
  - lipid peroxidation products, cytotoxic, rat liver microsomes, 235, 247
  - see also* Eicosanoids; Prostaglandin entries; Thromboxanes
- Arachidonic acid system activation, isolated rabbit lung, 289–298
  - alveolar hypoxia, 294–295
  - bacterial toxins, 295–296
  - complement, 292–293, 295
  - granulocytes, 292, 296–298
    - elastase, 296
    - oxygen radicals, 296
  - and hemodynamics, pulmonary, 289–298
    - PAP, 292–295
  - kallikrein-kinin system, 289, 291, 292
  - leukotrienes, 291, 293, 296
  - prostaglandins, 289, 291, 294–296
  - thromboxanes, 291, 293–297
- ARDS (adult respiratory distress syndrome) and complement in shock, 4, 6
  - development, kinin-induced pathology, kallikrein infusion, pig, 127–130
  - elastase and leukocyte counts, septic pig lung, 115, 118
  - granulocyte mediation of tissue injury, 23–24
  - pulmonary membranes, 75, 76, 78, 83–84
  - leukostasis, quantitative estimation, 50
  - limb ischemia, C3a and C5a as mediators of inflammation, 11

- microvascular permeability, septic shock, 487
- MOF, wound inflammatory mediators and, 534
- oxidant injury, cultured cells, 253
- physiologic-metabolic correlations, septic shock, 441, 446
- $\alpha_1$ -proteinase inhibitor bioavailability, injected vs. aerosolized, 203-204
- whole body inflammation, trauma patient autopsy study, 55-60
- see also* Alveolar cell reactions, posttraumatic lung failure and ARDS; Catecholamines, multiple trauma, and ARDS; Leukotrienes and lipid mediators in ARDS pathogenesis; Phospholipid lung profile, ARDS in polytrauma patients; Prostaglandin  $E_1$  administration in ARDS, septic and post-surgery patients
- Aryl sulfatase, 379
- Ascorbic acid, 276
- ATP, oxidant injury, cultured cells, 254
- Atrium, left, extracorporeal circulation, biochemical lung monitoring during CPB, 96-98, 101, 102, 104
- Atropine and heart rate in hypotensive central hypovolemia, 629-631
- Autopsy, leukostasis estimation, posttraumatic lung, 45-49
- diagnoses, 46-47
- see also under* Inflammation, whole body
- Bacterial toxins, arachidonic acid system activation, isolated lung, 295-296
- Bacteroides fragilis*, 447
- B cells, 5, 380
- BHT, 276
- Bilirubin, 11, 13-15, 17
- Bioavailability. *See*  $\alpha_1$ -Proteinase inhibitor bioavailability, injected vs. aerosolized
- Blood. *See* Coagulation; Oxygen and blood flow, regional differences, early sepsis; Oxygen free radicals, LPS generation, fresh human blood
- Blood pressure
- aprotinin and C1 esterase inhibitor infusion and pancreatic shock, pig, 193, 195
- plasma kallikrein-kinin system activation, 160-161
- eglin, elastase inhibitor, and lung edema, septic pigs, 123
- ETX shock (*E. coli*), dog model, 394, 395, 398
- multitherapy regimen for endotoxemia, hemodynamics, 229-230
- oxygen and blood flow, regional differences in early sepsis, 501
- trypsin-induced shock, hemodynamics and proteolysis, 189-191
- Body temperature
- BW755C in endotoxemia, 355, 357, 355, 357
- ibuprofen and ETX-stimulated inflammation, 340, 341
- Bradykinin, 93, 185, 190, 192, 289, 292
- ETX, cause of mediator release in sepsis, 380, 385, 387, 388
- kallikrein-kinin system activation, lung, *E. coli* septic sheep, 137-138
- multitherapy regimen for endotoxemia, pigs, 220-221
- Branched chain amino acids
- cardiovascular abnormalities, septic shock, 449, 451, 454-456
- leucine as heart depressant factor, 601
- Bronchoalveolar lavage
- alveolar cell reactions, posttraumatic lung failure and ARDS, 509-513
- elastase- $\alpha_1$ -PI complex and leukocyte counts, septic pig lung, 116-117, 115
- leukotriene generation, polytrauma patients with ARDS, 312-314
- and phospholipid lung profile, ARDS, 518, 520
- $\alpha_1$ -proteinase inhibitor bioavailability, injected vs. aerosolized, 203-205
- Bronchoscopy, 205
- Burns
- MOF, wound inflammatory mediators and, 525, 526, 528, 532
- infected cf. uninfected, 527
- nickel

- and heart depressant factors, 600
  - myocardial damage, 622
- Burn shock and resuscitation, 539–552
  - compliance, pulmonary, 550
  - dog, 541, 550
  - extravascular lung water, 548–550
  - fluid resuscitation, 543, 544, 552
  - hemodynamics, 540–543
  - human, 542, 543, 551
  - inhalation injury, 544–552
    - CO<sub>2</sub>, 546, 547, 551
    - intubation, 551–552
    - surfactant, 550–551
    - ventilation, 551
  - lymph, 549–550
  - microvascular permeability, 539–541, 549
  - mortality, 544, 545
  - plasma volume, 540–542
  - PMNs, 539–540, 547–549
  - pulmonary dysfunction, 544, 546
    - edema, 548–550, 552
  - sheep, 548, 551
  - thromboxanes, 541, 548
  - verapamil, 542
- Butylated hydroxytoluene, 276
- BW755C (NSAID) effect on endotoxemia, 302, 347–358
  - body temperature, 355, 357
  - cf. corticosteroids, 356–357
  - hemodynamics, 356–357
  - leukocytes, 347–350, 352, 353, 357
  - lipooxygenase and cyclooxygenase inhibition, 302, 347, 358
  - lymph flow, 347, 349, 353–355, 357
  - microvascular permeability, 348, 354, 357
  - platelets, 348, 351
  - rats, 347–352, 357
    - mortality, 349, 350
  - sheep, 347–349, 353–357
    - MPAP, 353, 357
  - thromboxane, 347, 350, 352, 355–357
- Calcium
  - binding, inotropic plasma substances, LMW, prolonged shock, 596
  - channel blockers, burn shock and resuscitation, 542; *see also* Verapamil
  - homeostasis, altered, myocardial dysfunction in sepsis, 579, 581, 583, 584, 587
    - transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 401–405, 409–410, 413–416
    - IP<sub>3</sub>-stimulated release, 413–415
- Camera, gamma, microvascular permeability, septic shock, 487, 491
- Capillaries. *See* Microvascular permeability, endotoxemia/septic shock
- Carbohydrate oxidation, flow or catabolic phase, 465, 466
- Carbon monoxide, inhalation injury, burn shock and resuscitation, 546, 547, 551
- Cardiac output
  - aprotinin and C1 esterase inhibitor infusion and pancreatic shock, pig, 194–195
- ETX
  - cause of mediator release in sepsis, 377, 381, 382, 385, 387, 388
  - shock (*E. coli*), dog model, 393–394, 396–398
  - ibuprofen and ETX-stimulated inflammation, 338, 340
  - multitherapy regimen for endotoxemia, hemodynamics, 216–218, 229, 233
  - myocardial dysfunction in sepsis, 575, 579, 584
  - oxygen and blood flow, regional differences in early sepsis, 496, 498
  - PGE<sub>1</sub> administration in ARDS, 361
  - physiologic-metabolic correlations, septic shock, 440–442
  - trypsin-induced shock, hemodynamics and proteolysis, 189–191
  - see also* Heart entries
- Cardiopulmonary bypass. *See* Kallikrein-kinin system activation during aorto-coronary bypass (CPB); *under* Extracorporeal circulation; Granulocytes, mediation of pulmonary membrane damage; Myocardial depressant factor
- Cardiovascular abnormalities, metabolic basis, 446–453, 455–456; *see also* Hemodynamics
- Catabolic phase, metabolic changes in injury, 463, 465–469



- cf. starvation, 465–466
- Catalase, oxygen free radicals and lung injury, 238, 240, 272, 274
- Catecholamines
  - heart stimulation, 599–600, 603–607
  - injury cf. sepsis, 469, 470
  - see also* Epinephrine (adrenaline)
- Catecholamines, multiple trauma, and ARDS, 477–481, 483–486
  - activation of
    - complement, 477, 478
    - kallikrein-kinin system, 477
  - activation of coagulation system, 477, 479–481
    - fibrin, 480–481
    - fibrinogen, 480–481
    - thrombin, 479, 480, 485–486
  - epinephrine, 478, 483–486
  - erythrocytes, 479
  - norepinephrine, 478, 483–486
  - pituitary and adrenal glands, 479
  - trauma scores, 478, 480, 484
- Cathepsin G, 124
- Ceruloplasmin, 272
- C1-esterase inhibitor, 191
  - and aprotinin, plasma kallikrein-kinin system activation, 159–163
  - and complement in shock, 4
  - and endotoxemia, 153
    - multitherapy regimen, pigs, 212, 213, 220, 221, 228
  - kallikrein system activation during CPB, 89, 92, 93
  - see also* Aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig
- C1-esterase inhibitor and elastase release, extracorporeal circulation, 107–113
  - antithrombin III, 108, 111
  - complement system inhibitor, 107
  - elastase- $\alpha_1$ -proteinase inhibitor complex, 107, 112, 113
  - $\beta$ -factor XIIIa, 108, 110
  - heparin, 108
  - kallikrein-kinin system inhibitor, 107–110, 113
  - prekallikrein, 107–109, 113
- C1-esterase inhibitor, early *E. coli* septicemia, pigs, 141–146
- antithrombin III, 142, 144
- $\alpha_1$ -antitrypsin, 144
- factor XIII, 142, 144
- leukocyte count, 143, 145
- lung edema, 144
- $\alpha_2$ -macroglobulin, 142, 143, 145
- platelets, 144
- prokallikrein, 142, 143, 145
- Chemiluminescence
  - neutrophils, alveolar cell reactions, post-traumatic lung failure and ARDS, 510–511
  - oxygen free radicals, LPS generation, blood, 420–422
    - lucigenin, 420, 422, 425
    - luminol, 420–424
    - superoxide radical, 422
- Chemotaxis and thrombin, lung microvascular injury, 33
- Chromatography, HPLC
  - leukotriene generation, polytrauma patients with ARDS, 312–313
  - lipid peroxidation products, cytotoxic, rat liver microsomes, 246–247
  - and phospholipid lung profile, ARDS, 517–521
  - reverse phase, inotropic LMW plasma substances, prolonged shock, 594
- Chromogenic substrates, 185, 186, 191, 213–215
- Chronotropic effects, myocardial dysfunction in sepsis, 576–578
- Cirrhosis, 365
- Clinical trial, PGE<sub>1</sub> administration in ARDS, 361–366
- Coagulation
  - activation, catecholamines, multiple trauma, and ARDS, 477, 479–481, 485–486
  - DIC, 59
  - MOF, 460, 462
  - protease inhibitors in endotoxemia, 153–154
  - see also* specific factors and system
- Cobra venom, 236–240, 380
- Colony stimulating factor, granulocyte-monocyte, 432–433
- Complement activation, 3–7

- alveolar cell reactions, posttraumatic lung failure and ARDS, 510, 512
- arachidonic acid system activation, isolated lung, 292–293, 295
- B cell function, 5
- C3a, 3–6, 77, 78, 85, 510, 512
- C3b opsonization, 15, 20
- C5a, 3–6, 20, 22–23, 77, 80, 81, 235, 237, 238, 274
- C5-derived chemotactic activity, 236–238
- catecholamines, multiple trauma, and ARDS, 477, 478
- C1 esterase inhibitor, 4
- ETX, cause of mediator release in sepsis, 379
- granulocyte mediation of tissue injury, 20–24
  - during CPB, 77–78, 84
- inhibition, C1-esterase inhibitor and elastase release, extracorporeal circulation, 107
- macrophages, 5
- methylmethacrylate cement in hip surgery, 6
- MOF, 3, 4, 7
  - ARDS, 4, 6
- oxygen free radicals and lung injury, 235–238
- whole body inflammation, trauma patient autopsy study, 59–60
- see also under* Ischemia
- Computers, 568
  - Apple II, 568
  - software, LAMS, 335, 337
- Contractility, 321–322, 567, 569, 574, 576, 579, 581, 584
- Corticosteroids cf. BW755C in endotoxemia, 356–357; *see also* specific steroids
- Cortisol, 467, 470
- CPAP, burn shock and resuscitation, 551
- Creatinine
  - aprotinin, very high dosage, polytrauma, 181
  - limb ischemia, C3a and C5a as mediators of inflammation, 13–15, 17
- CSF, granulocyte-monocyte, 432–433
- Cyclic AMP and cyclic GMP, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 402, 403
- Cyclooxygenase inhibition
  - BW755C in endotoxemia, 302, 327, 358
  - ibuprofen, 327–328
    - and ETX-stimulated inflammation, 334, 344
  - prostacyclin in ETX shock, 369–370
- Cysteinyl leukotrienes, 301, 303–307, 323
  - hepatobiliary elimination inhibited by ETX, 304, 305, 307
- Degranulation, leukostasis, quantitative estimation, 48–49
- Dextran sulfate, 160–163
- Dialysis-associated neutropenia, 21
- Diarrhea, ETX shock (*E. coli*), dog model, 394, 396
- Disseminated intravascular coagulation, 59
- DNA, single strand breaks, oxidant injury to cultured cells, 256–257
- Dog model, *E. coli* endotoxin shock, 393–398
- Ebselen (selenium compound), protection vs. endotoxin shock ingalactosamine-sensitized rodents, 281–287
  - eicosanoid metabolism interactions, diagram, 287
  - glutathione peroxidase, 282, 285, 286
  - hemodynamics, 282, 283
  - hepatitis, 281, 284, 285
  - leukotrienes, 281, 284–286
  - liver, 283, 284, 286
- ECG
  - antioxidant protection vs. free radical mediated myocardial injury, 635
  - Ni release, myocardial damage, 621–623, 625
- Eglin, elastase inhibitor, influence on lung edema, septic pigs, 121–124
  - antithrombin III, 122–124
  - blood pressure, 123
  - E. coli*, 121–122
  - extravascular lung water, 123
  - factor XIII, 122–124
  - $\alpha_2$ -macroglobulin, 122–124
  - plasma levels and urinary excretion, 122–123
- Eicosanoids

- ibuprofen and ETX-stimulated inflammation, 334, 342, 344
- metabolism, ebselen protection vs. ETX shock in galactosamine-sensitized rodents, 287
- see also* Arachidonic acid *entries*; specific eicosanoids
- Elastase, granulocyte
  - alveolar cell reactions, posttraumatic lung failure and ARDS, 510–513
  - aprotinin, cellular effects, 166–169
  - arachidonic acid system activation, isolated lung, 296
  - extracorporeal circulation, biochemical lung monitoring during CPB, 96, 97, 100–104
  - leukostasis, quantitative estimation, 50
  - proteinase inhibitor bioavailability, injected vs. aerosolized, 203, 207
  - release during CPB, mediator of pulmonary membrane damage, 82–83
  - see also* C1-esterase inhibitor and elastase release, extracorporeal circulation; Eglin, elastase inhibitor, influence on lung edema, septic pigs
- Elastase- $\alpha_1$ -proteinase inhibitor complex, and leukocyte counts, septic pig lung, 115–118
- ARDS, 115, 118
- bronchial washings, 116–117
- bronchoalveolar lavage, 115
- E. coli*, 116–118
- ELISA, 115–116
- Electron microscopy, Ni release and myocardial damage, 622, 625
- Electron spin, PBN, oxygen radical scavengers, 261, 262, 267, 268
- resonance, 261, 262, 267, 268
- trapping, 261–268
- ELISA, 115–116, 127, 130
- Endorphins, 212, 227
- $\beta$ -, 385, 389
- Endothelium/endothelial cells
  - aortic, oxidant injury, cultured cells, 254–255
  - damage after endotoxin activation, granulocyte mediation of tissue injury, 25–28
  - and platelets, 26
  - neutrophil adherence to, fibrin-neutrophil interactions, lung microvascular injury, 40
  - oxygen free radicals and lung injury, 236, 238
- Endotoxemia. *See also* BW755C (NSAID)effect on endotoxemia; Protease inhibitors in endotoxemia; Microvascular permeability, endotoxemia/septic shock; Transmembrane signaling perturbation, endotoxemia, rate hepatocyte
- Endotoxemia, multitherapy regimen, pigs, 211–222, 227–233
- antihistamine (promethazin), 212, 213, 222, 228
- antiplasmin, 216, 219
- gentamicin, 222
- hemodynamics, 216–221, 227–233
  - arterial blood pressure, 229–230
  - cardiac output, 216–218, 229, 233
  - left ventricular stroke work, 230, 231, 233
  - mean pulmonary artery pressure, 230
  - oxygen tension/saturation, 232, 233
  - PCWP, 232
  - pulmonary vascular resistance, 218, 220, 230, 231
  - Swan-Ganz catheter, 228
  - systemic vascular resistance, 216, 218, 219, 230
- kallikrein-kinin system activation, 212–215, 220, 221, 227
  - bradykinin, 220–221
- ketanserine, 212, 213, 222, 228
- methylprednisolone, 212, 213, 220–222, 228
- naloxone, 212, 213, 227, 228
- plasma endotoxin, chromogenic substrate measurement, 213–215
- protease inhibitors
  - antithrombin III, 212, 213, 216, 217, 220, 221, 228
  - aprotinin, 212, 213, 220, 228
  - C1-esterase inhibitor, 212–213, 220, 221, 228
- Endotoxemia, thromboxane synthetase inhibitors, 328–329

## Endotoxin (ETX)

- endothelial damage, granulocyte mediation of tissue injury, 25–28 and platelets, 26
  - leukotrienes as mediators of shock and tissue trauma, rat, 311–316
  - MOF, wound inflammatory mediators and, 527–532, 534
  - myocardial dysfunction in sepsis, 576, 584
    - cell membrane effect, 576
  - oxygen radical scavengers, prophylaxis and treatment, 262–264
  - receptor competition, lipid X inhibition of LPS neutrophil activation, 434
  - Salmonella abortus equi*, 282
  - see also* Ebselen (selenium compound), protection vs. endotoxin shock in galactosamine-sensitized rodents; Ibuprofen effect on ETX-stimulated inflammation
- Endotoxin, cause of mediator release in sepsis, overview, 377–389
- B cells, 380
  - bolus cf. infusion of pulses, 381–384, 386, 388
  - bradykinin, 380, 385, 387, 388
  - cardiac output, 377, 381–382, 385, 387, 388
  - leukotrienes, rat, 311–316
  - lymph flow, 379, 388, 389
  - microvascular permeability, 377, 379–381, 387, 388
    - shear rate, 387–388
  - myocardial depression, 387
  - opiates, endogenous, 385, 389
    - naloxone, 385, 389
  - PMNs, 378, 379, 387, 388
  - prostacyclin, 385
  - sheep model, 378–380, 384–384
  - T cells, 380, 388
  - thromboxane, 382
  - vascular resistance
    - peripheral, 377, 381–382, 385
    - systemic, 377
- Endotoxin shock
- dog model (*E. coli*), 393–398
    - arterial pressure, systemic and pulmonary, 394, 395, 398
    - cardiac output, 393–398
    - diarrhea, 394, 396
    - fluid infusion, 394, 395, 398
    - heart rate, 394, 395
    - lactate, 394, 396, 397
    - vascular resistance, systemic, 396, 397
  - ibuprofen, increased survival, 327–330
  - see also* Prostacyclin, intravenous, in endotoxin shock, rabbit; Septic shock *entries*
- Epinephrine (adrenaline), 467, 472, 473
- catecholamines, multiple trauma, and ARDS, 478, 483–486
  - transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 409–412
- Erythrocytes, catecholamines, multiple trauma, and ARDS, 479
- Escherichia coli*, 328, 402, 404, 420, 423, 447
- eglin, elastase inhibitor, and lungedema, septic pigs, 121–122
  - elastase and leukocyte counts, septic pig lung, 116–118
  - ETX shock, dog model, 393–398
  - MOF, ETX and, 528–529, 531
  - see also* C1-esterase inhibitor, early *E. coli* septicemia, pigs; Kallikrein-kinin system activation, lung, *E. coli* septic sheep
- Esterase stain, leukostasis, quantitative estimation, 45, 49
- Extracorporeal circulation
- biochemical lung monitoring during CPB, 95–104
    - apnoe, 96, 98–100, 103–104
    - elastase, granulocyte, 96, 97, 100–104
    - lysozyme, 97, 99–100, 104
    - NAG, 97–99, 101–104
    - PEEP, 96, 98, 100, 103, 104
    - vena cava superior cf. left atrium, 96–98, 101, 102, 104
  - kallikrein system activation during CPB, 87
  - MDF release during CPB, 611–619
  - see also* C1-esterase inhibitor and elastase release, extracorporeal circulation;

- Kallikrein-kinin system activation during aorto-coronary bypass (CPB)
- Extravascular lung water  
 alveolar cell reactions, posttraumatic lung failure and ARDS, 510–512  
 burn shock and resuscitation, 548–550  
 eglin, elastase inhibitor, and lung edema, septic pigs, 123  
 leukotriene generation, polytrauma patients with ARDS, 312–313  
*see also* Microvascular permeability, endotoxemia/septic shock
- $\beta$ -Factor XIIa  
 C1-esterase inhibitor and elastase release, extracorporeal circulation, 108, 110  
 prekallikrein activation, 93
- Factor XII (Hageman factor), 159, 162, 539, 540
- Factor XIIIf, prekallikrein activation, 93
- Factor XIII  
 C1-esterase inhibitor, early *E. coli* septicemia, pigs, 142, 144  
 eglin, elastase inhibitor, and lung edema, septic pigs, 122–124
- Fatoxidation, flow or catabolic phase of injury, 464, 465, 469
- Fatty acids, polyunsaturated, 245–246  
 4-hydroxynonenal, 246–250  
*see also* Arachidonic acid *entries*
- Fibrin  
 catecholamines, multiple trauma, and ARDS, 480–481  
 deposits, glomerular, prostacyclin in ETX shock, 371, 374, 375
- Fibrin–neutrophil interactions, lung microvascular injury, 33–41  
 HETEs, 40–41  
 leukotriene B<sub>4</sub>, 40–41  
 neutrophil  
 adherence to endothelium, 40  
 aggregation, 39  
 sequestration, lung, 37–39  
 permeability, increased, 34–35, 39  
 protein exchange, 34, 35, 39  
 pulmonary lymph flow, 34, 35, 38–40  
 thrombin, 33–41  
 chemotactic domain, 33  
 hirudin, 39  
 platelet, response, 35
- Fibrinogen, catecholamines, multiple trauma, and ARDS, 480–481
- Fibrinopeptide A, 274
- Flow phase, changes in injury, 463, 465–469  
*cf.* starvation, 465–466
- Fluid resuscitation  
 burn shock, 543, 544, 552  
 ETX shock (*E. coli*), dog model, 394, 395, 398  
 microvascular permeability, septic shock, 487–488, 490
- FMLP, 166–168, 429
- Free radicals. *See* Antioxidant *entries*; Lipid peroxidation *entries*; Oxygen free radicals *entries*
- Galactosamine, 301, 303, 306, 307  
 -sensitized mice, lipid X inhibition of LPS neutrophil activation, 431–432  
*see also* Ebselen (selenium compound), protection vs. endotoxin shock in galactosamine-sensitized rodents
- Gamma camera, microvascular permeability, septic shock, 487, 491
- Gastrointestinal system in MOF, 460, 532
- Gebexate mesilate, 154–155, 389
- Gentamicin, multitherapy regimen for endotoxemia, pigs, 222
- Glasgow Coma Scale, 622
- Glomerular fibrin deposits, prostacyclin in ETX shock, 371, 374, 375
- Glucose  
 cardiovascular abnormalities, septic shock, 447, 449–451, 454–455  
 injury *cf.* sepsis, 470–472  
 ischemia, small intestine, vascular perfusion, 504–505  
 oxidation, flow or catabolic phase, 464–466
- $\beta$ -Glucuronidase, ETX, cause of mediator release in sepsis, 379
- Glutathione peroxidase, ebselen protection vs. ETX shock in galactosamine-sensitized rodents, 282, 285, 286
- Glutathione, reduced (GSH)

- antioxidant protection vs. free-radical mediated myocardial injury, 635–639
- oxygen radical scavengers, prophylaxis and treatment, 261
- Glycerol, injury cf. sepsis, 472, 473
- Glycogen phosphorylase *a*, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 404, 405, 411–413, 416
- Granulocytes (PMNs)
  - accumulation in myocardial shock ischemia, 63–70
  - lidocaine, 65, 67–69
  - oxygen free radicals, 64
  - reperfusion, 65–66
  - activation, 253–254, 260
    - oxygen free radicals, LPS generation, blood, 419, 422, 424, 425
  - aggregation, antioxidant drugs, 276, 278
  - aprotinin, cellulareffects, 165–171
  - arachidonic acid system activation, isolated lung, 292, 296–298
    - oxygen radicals, 296
  - burn shock and resuscitation, 539–540, 547–549
  - ETX, cause of mediator release in sepsis, 378, 379, 387, 388
  - leukotriene generation, polytrauma patients with ARDS, 311, 314–315
  - limb ischemia and inflammation, 14–15
    - aggregation, 11, 16
  - monocyte CSF, 432–433
  - whole body inflammation, trauma patient autopsy study, 55, 58
  - see also* Elastase, granulocyte; Leukocyte(s); Neutrophils
- Granulocytes, mediation of pulmonary membrane damage, 75–85
- ARDS, 75, 76, 78, 83, 84
- cardiopulmonary bypass, 76–85
  - complement activation during, 77–78, 80, 84–85
  - elastase release during, 81–83
  - intrapulmonary sequestration, 79–81, 85
  - MDA levels, 79–80
  - oxygen free radical peroxidation, 79–81, 83–84
  - post-perfusion syndrome, 75, 83, 84
  - $\alpha_1$ -proteinase inhibitor, 83–84
  - whole body inflammation, 84
- Granulocytes, mediation of tissue injury, 19–28
  - activation and shock lung, 23–24
  - aggregation, 21–23
  - complement system activation, 20–24
  - endothelial damage after endotoxin activation, 25–28
    - and platelets, 26
  - free iron, 27–28
  - frustrated phagocytosis, 19–20
  - intravascular activation, 20–21
  - oxygen radicals, 26–28
  - pharmacology, 24–25
    - steroids, 24–26
  - $\alpha$ -1-proteinase inhibitor, 27
- GSH (reduced glutathione)
  - antioxidant protection vs. free-radical mediated myocardial injury, 635–639
  - oxygen radical scavengers, prophylaxis and treatment, 261
- Hageman factor (factor XII), 159, 162, 539, 540
- Hannover Trauma Scale, 521
- Heart
  - depressant factors, 599–603
    - acidosis, 600
    - isolated papillary muscle, 602, 603
    - leucine, 601
    - MDF, 591, 592, 596, 601–604
    - nickel, 600
    - vasopressin, 601
  - myocardial depression, physiologic-metabolic correlations, septic shock, 446, 454
  - rate
    - and atropine, in hypotensive central hypovolemia, 629–631
    - ETX shock (*E. coli*), dog model, 394–395
    - myocardial dysfunction in sepsis, 574–578, 587
    - stimulant factors in shock, 599–600, 603–607
      - catecholamines and angiotensin II, 603

- histamine, 604
- inotropic, 603, 604
- MSF, shock-induced, 604-607
- ventricular function
  - hypovolemic-traumatic shock, 561, 567
  - multitherapy regimen for endotoxemia, 230, 231, 233
  - physiologic-metabolic correlations, septic shock, 444
- see also* Cardiac output; Hemodynamics; Myocardial *entries*; Nickel release, endogenous, myocardial damage
- Heart performance evaluation, hypovolemic-traumatic shock, 561-570
  - cardiodynamics, schema, 562-563
  - closed-loop feed-back control circuits, 561, 569
  - computers, 568
  - contractility, 567, 569
  - myocardium performance, 561
  - separation of control circuits, 569
    - isolated heart-lung preparation, 569-570
  - ventricular performance, 561, 567
- Hemodialysis, MOF, 460, 461
- Hemodynamics
  - aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig, 193-195
  - arachidonic acid system activation, isolated lung, 289-298
    - PAP, 292-295
  - BW755C in endotoxemia, 356-357
  - eblesen protection vs. ETX shock in galactosamine-sensitized rodents, 282-283
  - ibuprofen, 327-328
  - kallikrein-kinin system activation, lung, *E. coli* septic sheep, 135, 137
  - MDF release during CPB, 612-616, 618-619
  - PGE<sub>1</sub> administration in ARDS, 363-365
  - see also* Hyperdynamic/hypermetabolic state; Trypsin-induced shock, hemodynamics and proteolysis, pigs; Vascular *entries*; *under* Endotoxemia, multitherapy regimen, pigs
- Hemorrhage, atropine effect on heart rate, 629, 630
- Heparin, extracorporeal circulation
  - C1-esterase inhibitor and elastase release, 108
  - kallikrein-kinin system activation during CPB, 87-89, 91
- Hepatitis, eblesen protection vs. ETX shock in galactosamine-sensitized rodents, 281, 284, 285
- Hepatocytes. *See* Transmembrane signaling perturbation, endotoxemia, rat hepatocyte
- HETE and HPETE, 40-41, 334
- Hip surgery, methylmethacrylate cement in, 6
- Hirudin and thrombin, lung microvascular injury, 39
- Histamine, 162, 212, 227
  - antihistamine in multitherapy regimen for endotoxemia, pig, 212, 213, 222, 228
  - heart stimulation, 604
  - leukotrienes and lipid mediators in ARDS pathogenesis, 318, 321, 322
- Hospital Trauma Index, 56
- HPLC. *See* Chromatography, HPLC
- 5HT. *See* Serotonin
- Hydrogen peroxide
  - injury
    - cultured cells, 253-254
    - lung, 238-249
      - myeloperoxidase, oxygen free radicals, LPS generation, blood, 422
- Hydroxyl radical, oxygen free radicals and lung injury, 238-241
  - and iron chelators, 239-240
- 4-Hydroxynonenal, lipid peroxidation products, cytotoxic, rat liver microsomes, 246, 248-250
- Hyperdynamic/hypermetabolic state
  - MOF, wound inflammatory mediators and, 525-526, 531-532
  - sepsis syndrome, 526-528, 533-534
  - myocardial dysfunction in sepsis, 574, 584, 585, 587

- physiologic-metabolic correlations, septic shock, 404–442, 454
- Hypovolemic shock. *See* Heart performance evaluation, hypovolemic-traumaticshock; Inotropic plasma substances, LMW, prolonged hypovolemic polytraumatic shock, dog
- Hypoxia, alveolar, arachidonic acid system activation, isolated lung, 294–295
- Ibuprofen, 378, 389
  - MOF, wound inflammatory mediators and, 534
  - see also* BW755C (NSAID) effect on endotoxemia
- Ibuprofen effect on ETX-stimulated inflammation, 333–344
  - arachidonic acid and eicosanoids, 334, 342, 344
  - body temperature, 340–341
  - cardiac index, 338, 340
  - cyclooxygenase inhibition, 334, 344
  - general NSAID mechanism, 334
  - lymph flow, 334, 335, 337, 344
  - microvascular permeability, 340, 342, 343
  - neutropenia, 333–334, 340
  - oxygen consumption, 337, 339–341, 344
  - plasma volume, 337
  - prophylactic/therapeutic, 335
  - pulmonary vascular tone, 336
  - systemic vascular resistance, 337, 338, 340, 344
- Immunoelectrophoresis, rocket, 177, 180
- Infant respiratory distress syndrome, 517, 521
- Inflammation, whole body
  - granulocyte mediators of pulmonary membrane damage, 84
  - trauma patient autopsy study, 55–60
    - complement, 59–60
    - liver, 58
    - MOF and ARDS, 55–60
    - organ weights, 56–60
    - PMNs, 55, 58
    - thromboplastin and DIC, 59
  - see also* BW755C (NSAID) effect on endotoxemia; Ibuprofen effect on ETX-stimulated inflammation;
  - Multiple organ failure, wound inflammatory mediators; *under* Ischemia
- Inhalation injury. *See under* Burn shock and resuscitation
- Injury Severity Score, 622
  - whole body inflammation, trauma patient autopsy study, 56–57
- Inositol phospholipid turnover, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 401–404, 407–409, 416
- Inotropic plasma substances, LMW, prolonged hypovolemic polytraumatic shock, dog, 591–596
  - calcium-binding, 596
  - HPLC, reverse phase, 594
  - cf.* myocardial depressant factor, 591, 592, 596
  - and papillary muscle, guinea pig bioassay, 592, 595
  - sodium chloride, 591–594
  - see also* Myocardial depressant factor
- Insulin, flow or catabolic phase, 466–469, 472
- Interleukin-1
  - changes in injury, 463, 469, 472
  - MOF, wound inflammatory mediators and, 531–534
  - protease inhibitors in endotoxemia, 150
- Interleukin-2, 447
- Intestinal ischemia, vascular perfusion, rat, 503–507
- Intravascular activation, granulocyte mediation of tissue injury, 20–21
- IP<sub>3</sub>, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 413–415
- Iron
  - ADP-, lipid peroxidation products, cytotoxic, rat liver microsomes, 247–249
  - antioxidant drugs, 272
  - chelators, oxygen free radicals and lung injury, 239–240
  - free, granulocyte mediation of tissue injury, 27–28
- Ischemia
  - limbs, C3a and C5a as mediators of inflammation, 11–17



- ARDS, 11
- bilirubin (liver function), 11, 13–15, 17
- creatinine (kidney function), 13–15, 17
- granulocytes, 14–15
- granulocytes, aggregation, 11, 16
- oxygen radicals, 15
- platelets, 14–16
- respiratory function, 11, 13–15, 17
- myocardial shock-, granulocyte accumulation, 63–70
- reperfusion, 65–66
- reperfusion, antioxidant protection vs. free-radical mediated myocardial injury, 634–639
- Isoproterenol, myocardial dysfunction in sepsis, 577, 578
- Kallikrein**
  - aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig, 194, 196–200
  - inhibition, 193, 194, 196, 197, 199
  - aprotinin inhibition, very high dosage, polytrauma, 175–181
  - infusion, kinin-induced pathology in ARDS development, pig, 127–130
  - bolus injection cf. continuous infusion, 128–129
  - trypsin-induced shock, hemodynamics and proteolysis, 185–188, 191
  - inhibition, 186, 189, 191
- Kallikrein-kinin system**
  - aprotinin and C1-esterase inhibitor, 159–163
  - arachidonic acid system, isolated lung, 289, 291–292
  - catecholamines, multiple trauma, and ARDS, 477
  - inhibition, C1-esterase inhibitor and elastase release, extracorporeal circulation, 107–110, 113
  - multitherapy regimen for endotoxemia, pigs, 212–215, 220–221, 227
  - protease inhibitors in endotoxemia, 149, 152–153
- see also* specific components
- Kallikrein-kinin system activation during aorto-coronary bypass (CPB), 87–93**
  - aprotinin, 87–89, 91, 93
  - C1-esterase inhibitor, 89, 92, 93
  - extracorporeal circulation, 87
  - heparin, 87–89, 91
  - kallikrein, 87–90, 92
  - inhibition, 87–89, 91–93
  - kininogen, HMW, 87–90
  - prekallikrein, 87–90, 93
  - activators, 93
- Kallikrein-kinin system activation, lung, *E. coli* septic sheep, 133–138**
  - antithrombin III, 134, 136–138
  - bradykinin, 137–138
  - hemodynamics, 135, 137
  - kallikrein inhibition, 134, 136–137
  - lymph flow, 134, 135, 137
  - prekallikrein, 134, 136, 137
  - prothrombin, 134, 136–138
- Ketanserin, multitherapy regimen for endotoxemia, pigs, 212, 213, 222, 228**
- Kidney**
  - aprotinin, very high dosage, polytrauma, 180–182
  - creatinine, 181
  - urine output, 180–181
  - function (creatinine), limb ischemia, C3a and C5a as mediators of inflammation, 13–15, 17
  - glomerular fibrin deposits, prostacyclin in ETX shock, 371, 374, 375
  - MOF, 460–462
- Kinin**
  - aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig, 199
  - induced pathology in ARDS development, kallikrein infusion, 127–130
  - inhibition, C1-esterase inhibitor and elastase release, extracorporeal circulation, 107–110, 113
  - see also* Kallikrein-kinin entries
- Kininogen**
  - aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig, 199
  - ARDS, pig, 127–129

- HMW**  
 aprotinin and C1-esterase inhibitor,  
 159, 161-162  
 during CPB, 87-90  
 Krebs-Henseleit solution, 503-507  
 Kupffer cells, 534
- Lactate**  
 ETX shock (*E. coli*), dog model, 394,  
 396, 397  
 physiologic-metabolic correlations, septic  
 shock, 446, 452
- Lactoferrin**, 510
- LAMS computer software**, 335, 337
- Langendorff perfused hearts**, myocardial  
 dysfunction in sepsis, 577
- Leucine**, heart depressant factor, 601
- Leukocyte(s)**  
 BW755C in endotoxemia, 347-350, 352,  
 353, 357  
 count, C1-esterase inhibitor, early *E. coli*  
 septicemia, pigs, 143, 145  
 prostacyclin in ETX shock, 370, 372,  
 375  
*see also* Elastase- $\alpha_1$ -proteinase inhibitor  
 complex, and leukocyte counts,  
 septic pig lung; Granulocytes  
*entries*; Neutrophils
- Leukocytosis**, MOF, wound inflammatory  
 mediators and, 530-531
- Leukostasis**, quantitative estimation, post-  
 traumatic lung cf. controls, 43-51  
 ARDS and MOF, 50  
 degranulation, 48-49  
 dogs, 43-45, 50  
 reinfusion, 44, 48, 50  
 elastase, 50  
 esterase stain, 45, 49  
 human autopsy cases, 45-49  
 diagnoses, 46-47  
 labeling, 44, 45, 48, 50-51
- Leukotrienes**  
 alveolar cell reactions, posttraumatic lung  
 failure and ARDS, 510-512  
 arachidonic acid system activation, iso-  
 lated lung, 291, 293, 296  
 ebselen protection vs. ETX shock in gal-  
 actosamine-sensitized rodents,  
 281, 284-286  
 fibrin-neutrophil interactions, lung mi-  
 crovascular injury, 40-41  
 MOF, wound inflammatory mediators  
 and, 531  
 Leukotrienes and lipid mediators in ARDS  
 pathogenesis, 317-324  
 and C5a, 317, 318, 320-324  
 and neutrophils, 324  
 and smooth muscle contraction,  
 321-322  
 histamine, 318, 321, 322  
 PAF, 317-323  
 chemical structure, 318, 319, 321  
 schema, 324  
 vascular permeability, 320-322  
 Leukotrienes as mediators of ETX shock and  
 tissue trauma, rat, 301-307  
 cysteinyl, 303-307, 323  
 hepatobiliary elimination inhibited by  
 ETX, 304-305, 307  
 LPS, pathogenesis mechanism, 306-307  
 Leukotrienes, generation, polytrauma pa-  
 tients with ARDS, 311-316  
 bronchoalveolar lavage, 312-314  
 extravascular lung water, 312-313  
 granulocytes, 311, 314-315  
 HPLC, 312, 313  
 RIA, 312, 313  
 Lidocaine, granulocyte accumulation in myo-  
 cardial shock ischemia, 65, 67-69  
 Limb ischemia. *See under* Ischemia
- Lipid(s)**  
 cardiovascular abnormalities, septic  
 shock, 447, 452-455  
 fat oxidation in injury, 464, 465, 469  
*see also* Leukotrienes and lipid mediators  
 in ARDS pathogenesis  
 Lipid peroxidation, 274, 275  
 antioxidant protection vs. free-radical me-  
 diated myocardial injury, 633-639  
 MDA, 635, 636  
 oxygen free radicals and lung injury,  
 239-241  
 Lipid peroxidation products, cytotoxic, rat  
 liver microsomes, 245-250  
 ADP-iron, 247-249  
 aldehyde, 245-248  
 malondialdehyde, 247, 249

- HPLC, 246, 247  
 PUFA, 245, 246  
   4-hydroxynonenal, 246, 248–250  
   toxic second messengers, 249
- Lipid X inhibition of LPS neutrophil activation, 427–434  
 ETX receptor competition, 434  
 galactosamine-sensitized mice, 431–432  
 lungs, 431, 433  
 cf. other lipid A monosaccharide derivatives, 427, 429, 430, 432  
 oxygen free radicals, 427, 432  
   superoxide, 427–429, 431
- Lipopolysaccharide, 378, 380, 385, 387, 389  
 leukotrienes as mediators of ETX shock and tissue trauma, 306–307  
*see also* Lipid X inhibition of LPS neutrophil activation; Oxygen free radicals, LPS generation, fresh human blood
- Lipoxygenase inhibition, BW755C in endotoxemia, 302, 347, 358
- Liver  
 cirrhosis, PGE<sub>1</sub> administration in ARDS, 365  
 cysteinyl leukotriene elimination inhibited by ETX, 304, 305, 307  
 ebselen protection vs. ETX shock in galactosamine-sensitized rodents  
   enzymes, 283, 284, 286  
   toxicity, 284  
 function, limb ischemia, C3a and C5a as mediators of inflammation, 11, 13–15, 17  
 MOF, 460, 462  
   Kupffer cell, 534  
   wound inflammatory mediators and, 534  
 whole body inflammation, trauma patient autopsy study, 58  
*see also* Lipid peroxidation products, cytotoxic, rat liver microsomes; Transmembrane signaling perturbation, endotoxemia, rat hepatocyte
- Lucigenin, oxygen free radicals, LPS generation, blood, 420, 422, 425
- Luminol, oxygen free radicals, LPS generation, blood, 420–424
- Lungs  
 aprotinin, very high dosage, polytrauma, 180, 182  
 biochemical monitoring during CPB, 95–104  
 infant RDS, 517, 521  
 lipid X inhibition of LPS neutrophil activation, 431, 433  
 MOF, 460–462  
 phospholipid profile, ARDS in polytrauma patients, 517–521  
 postperfusion, 100, 102, 104  
 surfactant  
   ARDS, 517, 520  
   phospholipids, burn shock and resuscitation, 550–551  
 ventilatory management, 455, 551  
*see also* Alveolar entries; Arachidonic acid system activation, isolated rabbit lung; ARDS (adult respiratory distress syndrome); Eglin, elastase inhibitor, influence on lung edema, septic pigs; Elastase- $\alpha_1$ -proteinase inhibitor complex, and leukocyte counts, septic pig lung; Fibrin–neutrophil interactions, lung microvascular injury; Granulocytes, mediation of pulmonary membrane damage; Leukostasis, quantitative estimation, posttraumatic lung cf. controls; Oxygen free radicals and lung injury, rat; Pulmonary entries; Respiratory entries
- Lymph flow  
 BW755C in endotoxemia, 347, 349, 353–355, 357  
 ETX, cause of mediator release in sepsis, 379, 388, 389  
 ibuprofen and ETX-stimulated inflammation, 334, 335, 337, 344  
 kallikrein-kinin system activation, lung, *E. coli* septic sheep, 134, 135, 137  
 microvascular permeability, septic shock, 490  
 MOF, wound inflammatory mediators and, 531

- pulmonary, fibrin–neutrophil interactions, lung microvascular injury, 34, 35, 38–40
- Lysophosphatidylcholine, ARDS in poly-trauma, 519–521
- Lysosomal enzymes, extracorporeal circulation, biochemical lung monitoring during CPB, 95, 96, 102–103
- lysozyme, 97, 99–100, 104
- NAG, 97–99, 101–104
- see also* Elastase, granulocyte
- Lysozyme, 97, 99–100, 104
- Macaca mulatta*, 115
- $\alpha_2$ -Macroglobulin, 92, 199
- binding, trypsin-induced shock, hemodynamics and proteolysis, 191
- C1-esterase inhibitor, early *E. coli* septicemia, pigs, 142, 143, 145
- eglin, elastase inhibitor, and lung edema, septic pigs, 122–124
- protease inhibitors in endotoxemia, 151
- Macrophage(s)
- and complement in shock, 5
- like cell line P388D<sub>1</sub>, oxidant injury, 254–256
- myocardial dysfunction in sepsis, 587
- Malondialdehyde (MDA)
- antioxidant protection vs. free radical mediated myocardial injury, 635–636
- formation, and antioxidant drugs, 276, 278
- granulocyte mediators of pulmonary membrane damage, CPB, 79–80
- rat liver microsomes, 247, 249
- Membrane
- damage. *See* Granulocytes, mediation of pulmonary membrane damage; Lipid peroxidation *entries*
- stabilization, ibuprofen, 329
- Mercaptopropionylglycine, 276
- Mesenteric artery, superior, ischemic small intestine, vascular perfusion, 503
- Metabolic control changes in injury, 463–474
- flow or catabolic phase, 463, 465–469
- cf. starvation, 465–466
- cf. sepsis, 465, 469–472
- see also* Hypodynamic/hypermetabolic state; Septic shock, physiologic and metabolic correlations, humans
- Methylmethacrylate cement in hip surgery, 6
- Methylprednisolone
- MDF release during CPB, 611, 613–615, 617–618
- multitherapy regimen for endotoxemia, pigs, 212, 213, 220–222, 228
- cf. PBN, oxygen radical scavengers, prophylaxis and treatment, 263, 268
- Microsomes. *See* Lipid peroxidation products, cytotoxic, rat liver microsomes
- Microvascular injury. *See* Fibrin–neutrophil interactions, lung microvascular injury
- Microvascular permeability, endotoxemia/septic shock, 347–352, 357, 487–491
- albumin flux, labeled, *E. coli* septic shock, 490–491
- ARDS, 487
- BW755C, 348, 354, 357
- ETX, cause of mediator release in sepsis, 377, 379–381, 387, 388
- shear rate, 387–388
- fluid resuscitation, 487–488, 490
- gamma camera, 487, 491
- ibuprofen and ETX-stimulated inflammation, 340, 342, 343
- leukotrienes and lipid mediators in ARDS, 320–322
- lymph flow, 490
- plasma volume, 489–490
- protease inhibitors, 150–151
- transcapillary escape rate, 489
- Mitochondria, 253, 260, 267
- MOF. *See* Multiple organ failure *entries*
- Monitoring. *See under* Extracorporeal circulation
- Mortality, Ni release, myocardial damage, 623
- $\alpha$ -MPG, 276
- MTDQ-DA, 633, 636, 639
- Multiple organ failure (MOF, MSOF)
- and complement in shock, 3, 4, 7
- ARDS, 4, 6
- leukostasis, quantitative estimation, 50

- physiologic-metabolic correlations, septic shock, 442, 443, 451, 455  
 septic patients, 459-462  
 whole body inflammation, trauma patient autopsy study, 55-60
- Multiple organ failure, wound inflammatory mediators, 525-535**  
 ARDS, 534  
 burns, 525, 526, 528, 532  
   infected cf. uninfected, 527  
 ETX, 527-532, 534  
   GI permeability, 532  
   prostaglandins, 529-530, 532, 534, 535  
   recurrent low-dose endotoxemia, hemodynamics, 528-529, 531  
   thromboxanes, 529-531  
 hyperdynamic, hypermetabolic state, 525-526, 531-532  
   sepsis syndrome, 526-528, 533-534  
 interleukin-1, 531-534  
 leukocytosis, 530-531  
 leukotrienes, 531  
 liver, 534  
 lymph flow, 531  
 mediators listed, 527  
 oxygen consumption, 525-527, 532  
 prevention, 534-535  
   ibuprofen, 534  
   sheep, 527, 531
- Multiple trauma. See Aprotinin, very high dosage, polytrauma; Catecholamines, multiple trauma, and ARDS; Inotropic plasma substances, LMW, prolonged hypovolemic polytraumatic shock, dog; Leukotrienes, generation, polytrauma patients with ARDS; Phospholipid lung profile, ARDS in polytrauma patients**
- Multitherapy regimen. See Endotoxemia, multitherapy regimen, pigs**
- Muscle**  
 papillary, 592, 595, 602, 603  
 PO<sub>2</sub>, oxygen and blood flow, regional differences in early sepsis, 495, 496, 501  
 skeletal, cardiovascular abnormalities, septic shock, 447-449  
 smooth, contraction, leukotrienes and lipid mediators in ARDS pathogenesis, 321-322  
   *see also Myocardial entries*  
 Myeloperoxidase, 422, 510  
 Myocardial depressant factor, 591, 592, 596, 601-604  
   inotropic, 602  
   release during CPB, 611-619  
     aprotinin effect, 611, 613-615, 617-618  
     effects, 616-617  
     hemodynamics, 612-616, 618-619  
     methylprednisolone effect, 611, 613-615, 617-618  
     postperfusion syndrome, 616  
 Myocardial dysfunction in sepsis, rat, 573-587  
    $\beta$ -adrenergic stimulation, 576-577  
     isoproterenol, 577-578  
   calcium homeostasis, altered, 579, 581, 583, 584, 587  
   cardiac output, 575, 579, 584  
   chronotropic effects, 576-578  
   contractility, 574, 576, 579, 581, 584  
   endotoxin, 387, 576, 584  
     cell membrane effect, 576  
   heart rate, 574-578, 587  
   hyperdynamic, hypermetabolic state, 574, 584, 585, 587  
   Langendorff perfused hearts, 577  
   left atrial filling pressure, 580  
   macrophage, 587  
   oxygen consumption, 579, 585, 586  
   phosphate inadequacy, 579, 585  
   physiologic-metabolic correlations, septic shock, 446, 454  
   stroke volume, 574-576  
   ventricular performance, 573, 577, 579, 581, 582  
     compliance, 581  
   *see also Antioxidant protection vs. free radical mediated myocardial injury, dogs; Nickel release, endogenous, myocardial damage; under Granulocytes (PMNs)*
- Myocardial performance, hypovolemic-traumatic shock, 561**

- Myocardial stimulation factor, shock-induced, 604–607
- NAD, 255–257
- NADPH oxidase, 253, 260
- Naja naja cobra*, 236–240
- Naloxone, 212, 213, 227, 228, 385, 389
- Neutropenia
  - dialysis-associated, 21
  - ibuprofen and ETX-stimulated inflammation, 333–334, 340
- Neutrophils
  - chemiluminescence, alveolar cell reactions, posttraumatic lung failure and ARDS, 510–511
  - leukotrienes and lipid mediators in ARDS pathogenesis, 324
  - oxygen free radicals and lung injury, 235–239
    - proteinase release, 238–239
  - $\alpha_1$ -proteinase inhibitor bioavailability, injected vs. aerosolized, 203–204
  - see also* Fibrin–neutrophil interactions, lung microvascular injury; Granulocytes *entries*; Lipid X inhibition of LPS neutrophil activation
- Nickel release, endogenous, myocardial damage, 600, 621–626
  - burns, 622
  - cause of death, 623
  - ECG records, 621–623, 625
  - EM, 622, 625
  - serum levels, 621, 624
- Nitrogen loss, flow or catabolic phase, 465–469
- No reflow phenomenon, 63
- Norepinephrine, multiple trauma, and ARDS, 478, 483–486
- NSAID mechanism, 334; *see also* BW755C (NSAID) effect on endotoxemia; Ibuprofen *entries*
- Opiates, endogenous (endorphins), 212, 227, 385, 389
- Organ failure. *See* Multiple organ failure *entries*
- Organ weights, whole body inflammation, trauma patient autopsy study, 56–60
- Ouabain, 581, 583
- Oxidant injury of cultured cells, 253–258
  - ARDS, 253
  - and ATP content, 254
  - bovine aortic endothelial cells, 254–255
  - DNA, SSB, 256–257
  - H<sub>2</sub>O<sub>2</sub>, 253–254
  - mouse macrophage-like cell line P388D<sub>1</sub>, 254–256
    - and NAD content, 255–257
  - poly-ADP-ribose polymerase, 255–257
- Oxidative inactivation,  $\alpha_1$ -proteinase inhibitor, injected vs. aerosolized, 203–204
- Oxygen
  - consumption, 337, 339–341, 344, 500
    - MOF, wound inflammatory mediators and, 525–527, 532
    - myocardial dysfunction in sepsis, 579, 585, 586
    - physiologic–metabolic correlations, septic shock, 444, 454
  - delivery and consumption, PGE<sub>1</sub> administration in ARDS, 361, 364–367
  - pressure
    - alveolo-arterial difference (AaDO<sub>2</sub>), posttraumatic lung failure and ARDS, 510
    - partial, 495–497, 501, 504–505
    - tension/saturation, multitherapy regimen for endotoxemia, 232, 233
- Oxygen and blood flow, regional differences, early sepsis, 495–502
  - arterial blood pressure, 501
  - arterial oxygen transport, 499
  - cardiac output, 496, 498
  - maldistribution, 501–502
  - PO<sub>2</sub>, 495–497
    - muscle, 495–496, 501
- Oxygen free radicals
  - arachidonic acid system activation, isolated lung, 296
  - ETX, cause of mediator release in sepsis, 379, 380
  - granulocyte
    - accumulation in myocardial shock ischemia, 64
    - mediation of tissue injury, 26–28
  - limb ischemia, C3a and C5a as mediators of inflammation, 15

- lipid X inhibition of LPS neutrophil activation, 427, 432
- peroxidation, granulocyte mediators of pulmonary membrane damage, CPB, 79–81, 83, 84  
MDA levels, 79–80
- protease inhibitors in endotoxemia, 150–151  
*see also* Lipid peroxidation *entries*; Oxidant injury of cultured cells
- Oxygen free radicals and lung injury, rat, 235–241  
catalase, 238, 240, 272, 274  
cobra venom factor, 236–240  
complement, 235–238  
endothelial cells, 236, 238  
H<sub>2</sub>O<sub>2</sub>, 238–239  
hydroxyl radical, 238–241  
and iron chelators, 239–240  
lipid peroxidation, 239–241  
neutrophils, 235–239  
proteinase release, 328–239  
platelets, 235–236  
SOD, 238, 272, 274  
superoxide radical, 238–239
- Oxygen free radicals, LPS generation, fresh human blood, 419–425  
chemiluminescence, 420–422  
lucigenin, 420, 422, 425  
luminol, 420–424  
superoxide radical, 422
- PMN activation, 419, 422, 424, 425
- Oxygen free radical scavengers, prophylaxis and treatment of experimental shock, rat, 259–268  
ETX, 262–264  
PBN, 261–268  
electron spin reponse, 261, 262, 267–268  
cf. methylprednisolone, 263, 268  
reduced glutathione,  $\alpha$ -tocopherol, SOD, 261  
SMAO, 262–264  
trauma, 262–267  
*see also* Antioxidant *entries*
- PAF, 317–323  
chemical structure, 318, 319, 321
- Pancreatitis, 127, 128, 130
- MOF, 461  
*see also* Aprotinin and C1-esterase inhibitor infusion and pancreatic shock, pig
- Papillary muscle, 595, 595, 602, 603
- Parenteral nutrition, injury cf. sepsis, 470
- Partial oxygen pressure (PO<sub>2</sub>)  
ischemia, small intestine, vascular perfusion, 504–505  
regional differences in early sepsis, 495–497  
muscle, 495, 496, 501
- PBN, oxygen radical scavenger, prophylaxis and treatment, 261–268
- PEEP, burn shock and resuscitation, 551
- Permeability, GI, MOF, 532; *see also* Microvascular permeability, endotoxemia/septic shock
- Peroxidation, lipid. *See* Lipid peroxidation *entries*
- pH  
heart depressant factor, acidosis, 600  
ischemia, small intestine, vascular perfusion, 504–505
- Phagocytosis  
aprotinin, cellular effects, 169, 171  
frustrated, granulocyte mediation of tissue injury, 19–20
- Phenyl-t-butyl-nitron (PBN), oxygen radical scavenger, prophylaxis and treatment, 261–268
- Phosphate inadequacy, myocardial dysfunction in sepsis, 579, 585
- Phosphatidic acid  
ARDS in polytrauma, 519, 521  
transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 402, 404, 408
- Phosphatidylcholine, phosphatidylethanolamine, 519–521
- Phosphatidylglycerol, 517–521
- Phosphatidylinositol  
ARDS in polytrauma, 517, 519–521  
transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 402–404, 408, 409, 416
- Phosphatidylserine, 519, 521
- Phospholipase

- A<sub>2</sub>, 170  
 C, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 404, 407
- Phospholipid lung profile, ARDS in polytrauma patients, 517–521  
 bronchoalveolar lavage, 518, 520  
 HPLC, 517–519, 521  
 cf. infant RDS, 517, 521  
 and surfactant abnormality, 517, 520
- PIP and PIP<sub>2</sub>, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 404, 407, 409, 414
- Pituitary, 479
- Plasma  
 eglin, elastase inhibitor, and lung edema, septic pigs, 122–123  
 volume  
 burn shock and resuscitation, 540–542  
 microvascular permeability, septic shock, 489, 490  
*see also* Inotropic plasma substances, LMW, prolonged hypovolemic polytraumatic shock
- Plasmin inhibition, aprotinin, very high dosage, polytrauma, 179
- Platelet(s)  
 activating factor, 317–323  
 chemical structure, 318, 319, 321  
 aggregation, PGE<sub>1</sub> administration in ARDS, 367  
 aprotinin  
 cellular effects, 165, 170, 171  
 and C1-esterase inhibitor, plasma kallikrein-kinin system activation, 160  
 BW755C in endotoxemia, 348, 351  
 C1-esterase inhibitor, early *E. coli* septicemia, pigs, 144  
 granulocyte mediation of tissue injury, 26  
 limb ischemia, C3a and C5a as mediators of inflammation, 14–16  
 oxygen free radicals and lung injury, 235–236  
 prostacyclin in ETX shock, 370–375  
 and thrombin, lung microvascular injury, 35
- PMNs. *See* Granulocytes *entries*
- Poly-ADP-ribose polymerase antioxidant injury, 255–257
- Polytrauma scale, 510; *see also* Multiple trauma
- Polyunsaturated fatty acids, 245–246  
 4-hydroxynonenal, 246–250  
*see also* Arachidonic acid *entries*
- Postperfusion syndrome, 75, 83, 84  
 lung, 100, 102, 104  
 MDF release during CPB, 616
- Prazosin, 407
- Prekallikrein  
 C1-esterase inhibitor  
 and aprotinin, 159, 161–162, 194, 196, 199, 200  
 early *E. coli* septicemia, pigs, 142, 143, 145  
 and elastase release, extracorporeal circulation, 107–109, 113  
 during CPB, 87–90, 93  
 lung, *E. coli* septic sheep, 134, 136  
 trypsin-induced shock, hemodynamics and proteolysis, 186, 188  
*see also* Kallikrein-kinin system *entries*
- Promethazin, multitherapy regimen for endotoxemia, pigs, 212, 213, 222, 228
- Propyl-gallate, 276
- Prostacyclin, 385
- Prostacyclin, intravenous, in endotoxin shock, rabbit, 369–375  
 cyclooxygenase product, 369–370  
 glomerular fibrin deposits, 371, 374, 375  
 hemodialysis product, 371, 373–375  
 leukocytes, 370, 372, 375  
 PGI<sub>2</sub> infusion, 362–375  
 platelets, 370–375  
 and thromboxane, 369–375  
 vasodilation, 369
- Prostaglandin E<sub>1</sub> administration in ARDS, septic and post-surgery patients, 361–367  
 cardiac index, 363, 365–367  
 cardiac output, 361  
 cirrhosis, 365  
 hemodynamics, 363–365  
 oxygen delivery and consumption, 361, 364–367  
 platelet aggregation, 367



- pulmonary vascular resistance, 363, 365–367
- trial, 361–366
- vasoconstriction, 366
- Prostaglandins, 15, 16, 212, 222, 305, 307
- arachidonic acid system activation, isolated lung, 289, 291, 294–296
- flow or catabolic phase, 469
- MOF, ETX and, 529–530, 532, 534, 535
- PGI<sub>2</sub> infusion in ETX shock, 372–375
- Protease inhibitors in endotoxemia, 149–155
- α<sub>1</sub>-antiprotease, 151–152
- blood coagulation cascade, 153–154
- C1-esterase inhibitor, 153
- interleukin-1, 150
- kallikrein-kinin system, 149, 152–153
- α<sub>2</sub>-macroglobulin, 151
- microvascular permeability, 150–151
- neutrophils, oxygen free radicals and lung injury, 238–239
- oxygen free radicals, 150–151
- proteases in endotoxemia, 149–151
- see also* Endotoxemia, multitherapy regimen, pigs; specific proteases and inhibitors
- α<sub>1</sub>-Proteinase inhibitor, 151–152, 253
- deficiency, 207
- granulocyte mediation of tissue injury, 27
- pulmonary, 83–84
- α<sub>1</sub>-Proteinase inhibitor bioavailability, injected vs. aerosolized, dogs, 203–209
- ARDS, 203–204
- bronchoalveolar lavage, 203–205
- bronchoscopy, 205
- neutrophils, 203–204, 207
- oxidative inactivation, 203–204
- pulmonary penetration, 204–209
- Protein exchange, fibrin–neutrophil interactions, lung microvascular injury, 34, 35, 39
- Protein kinase C, transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 403
- Proteolysis inducing factor, 447; *see also* Trypsin-induced shock, hemodynamics and proteolysis, pigs
- Prothrombin, kallikrein-kinin system activation, lung, *E. coli* septic sheep, 134, 136–138
- Pseudomembranes, inhalation injury, 547
- Pseudomonas*, 378
- aeruginosa*, 295
- Pulmonary artery pressure
- arachidonic acid system activation, isolated lung, 292–295
- BW755C in endotoxemia, 353, 357
- ETX shock (*E. coli*), dog model, 394, 395, 398
- multitherapy regimen for endotoxemia, hemodynamics, 230
- Pulmonary capillary wedge pressure, 232
- Pulmonary compliance, burn shock and resuscitation, 550
- Pulmonary edema, C1-esterase inhibitor, early *E. coli* septicemia, pigs, 144; *see also* Eglin, elastase inhibitor, influence on lung edema, septic pigs
- Pulmonary lymph flow, fibrin–neutrophil interactions, lung microvascular injury, 34, 35, 38–40
- Pulmonary membrane damage. *See under* Granulocytes, mediation of pulmonary membrane damage
- Pulmonary vascular resistance. *See under* Vascular resistance
- Pulmonary vasculature, ibuprofen and ETX-stimulated inflammation, 336
- Pyruvate dehydrogenase, cardiovascular abnormalities, septic shock, 447–449, 451–452
- Quin-2, calcium measurement, 405
- Radioimmunoassay, leukotriene generation, polytrauma patients with ARDS, 312, 313
- Regional flow. *See* Oxygen and blood flow, regional differences, early sepsis
- Reperfusion
- granulocyte accumulation in myocardial shock ischemia, 65–66
- ischemia-, antioxidant protection vs. free radical mediated myocardial injury, 634–639
- Resistance. *See* Vascular resistance
- Respiratory function, limb ischemia, C3a and C5a as mediators of inflammation, 11, 13–15, 17

- Respiratory quotient, flow or catabolic phase, 464, 465
- Salmonella*  
*abortus equi*, 282, 421, 423  
*minnesota*, 301, 303
- Scavengers. *See* Antioxidant entries; Oxygen free radical scavengers, prophylaxis and treatment of experimental shock, rat
- Second messengers, toxic, lipid peroxidation products, 249
- Selenium. *See* Ebselen (selenium compound), protection vs. endotoxin shock in galactosamine-sensitized rodents
- Sepsis/septicemia  
 cf. changes in injury, 465, 467–472  
 multiple organ failure, 459–462  
 syndrome, MOF, wound inflammatory mediators and, 526–528, 533–534  
*see also* C1-esterase inhibitor, early *E. coli* septicemia, pigs; Eglin, elastase inhibitor, influence on lungedema, septic pigs; Elastase- $\alpha_1$ -proteinase inhibitor complex, and leukocyte counts, septic pig lung; Kallikrein-kinin system activation, lung, *E. coli* septic sheep; Microvascular permeability, endotoxemia/septic shock; Myocardial dysfunction in sepsis, rat; Oxygen and blood flow, regional differences, early sepsis; Prostaglandin E<sub>1</sub> administration in ARDS, septic and post-surgery patients
- Septic shock, ibuprofen, increased survival, 327–330
- Septic shock, physiologic and metabolic correlations, humans, 439–456  
 A–D states, 446  
 ARDS, 441, 446  
 cardiac abnormalities, metabolic basis, 446–453, 455–456  
 hemodynamics, 440–442, 454  
 cardiac output, 440–442  
 vascular tone, 442, 444  
 lactate, 446, 452
- MOF, 442, 443, 451, 455  
 protease inhibitors, 453  
 protein reprioritization, 453–454  
 myocardial depression, 446, 454  
 patterns of sepsis, cf. reference control state, 443–446  
 oxygen consumption, 444, 454  
 ventricular function, 444  
 therapy, 454–456  
 ventilatory management, 455  
*see also* Endotoxin shock
- Serotonin (5HT), 162, 212, 227  
 antagonist ketanserin, 212, 213, 222, 228
- Signaling. *See* Transmembrane signaling perturbation, endotoxemia, rat; hepatocyte
- Simplified Acute Physiologic Score, 622
- Small intestine, ischemia, vascular perfusion, 503–507
- SMAO, oxygen radical scavengers, prophylaxis and treatment, 262–264
- Sodium chloride, 591–594
- Sphingomyelin, ARDS in polytrauma, 519–521
- Spin resonance, oxygen radical scavengers, prophylaxis and treatment, 261, 262, 267, 268
- Staphylococcal  $\alpha$ -toxin, 295–296
- Starvation cf. flow or catabolic phase of injury, 465–466
- Steroids, granulocyte mediation of tissue injury, 24–26; *see also* specific steroids
- Superoxide dismutase (SOD), 428, 429  
 antioxidant protection vs. free radical mediated  
 myocardial injury, 635–639  
 aprotinin, cellular effects, 166  
 and lung injury, 238, 272, 274  
 prophylaxis/treatment, 261
- Superoxide radical  
 aprotinin, cellular effects, 165, 166, 169  
 lipid X inhibition of LPS neutrophil activation, 427–429, 431  
 LPS generation, blood, 422  
 and lung injury, 238–239  
*see also* Oxygen free radicals entries
- Surgery, hip, 6; *see also* Prostaglandin E<sub>1</sub> administration in ARDS, septic and post-surgery patients

## Survival

- aprotinin and C1 esterase inhibitor infusion and pancreatic shock, pig, 193
- ibuprofen increases, 327-330

T cells, 380, 388

Temperature, body. *See* Body temperature

## Thrombin

- catecholamines, multiple trauma, and ARDS, 479, 480, 485, 486
- and fibrin-neutrophil interactions, lung microvascular injury, 33-41

Thromboplastin, 59

Thromboxanes, 305, 307

- arachidonic acid system activation, isolated lung, 291, 293-297
- burn shock and resuscitation, 541, 548
- BW755C in endotoxemia, 347, 350, 352, 355-357
- ETX, cause of mediator release in sepsis, 382
- MOF, ETX and, 529-531
- prostacyclin in ETX shock, 369-375

Thromboxane synthetase inhibitors, rat ETX, 328-329

TNF, 469, 472

$\alpha$ -Tocopherol, 261, 272, 276

Transferrin, 272, 274

Transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 401-416

- $\alpha_1$ -adrenergic receptors, 406-407, 415
- $Ca^{2+}$ , 401-405, 409-410, 413-416
- IP<sub>3</sub>-stimulated release, 413-415
- Quin-2 measurement, 405

cAMP, 402

cGMP, 402-403

epinephrine, 409-412

glycogen phosphorylase  $\alpha$ , 404, 405, 411-413, 416

inositol phospholipid turnover, 401-404, 407-409

phosphatidic acid, 402, 404, 408

phosphatidylinositol, 402-404, 408-409, 416

PIP and PIP<sub>2</sub>, 404, 407-409, 414

protein kinase C, 403

phospholipase C, 404, 407

vasopressin, 402, 404, 407-412, 415

receptors, 405-406, 415

Trauma. *See* Heart performance evaluation, hypovolemic-traumatic shock; Leukostasis, quantitative estimation, post-traumatic lung cf. controls; Leukotrienes as mediators of ETX shock and tissue trauma, rat; Multiple trauma; *under* Inflammation, whole body

Trauma scores, catecholamines, and ARDS, 478, 480, 484

Triglyceride abnormalities, septic shock, 447, 452-455

Trypsin-induced shock, hemodynamics and proteolysis, pigs, 185-192

blood pressure (MAP), 189-191

cardiac output, 189-191

chromogenic peptide substrate analysis, 185, 186, 191

kallikrein, 185-188, 191

inhibition, 186, 188, 191

$\alpha_2$ -macroglobulin binding, 191

prekallikrein, 186, 188

trypsin, plasma activity, 186, 187

vascular resistance, systemic, 190-191

Tyrosine, 442

## Urinary excretion

eglin, septic pigs, 122-123

very high dosage aprotinin, polytrauma, 180-181

Vagal activity, atropine effect on heart rate, 629, 631

Vascular perfusion, intestinal ischemia, rat, 503-507

Vascular permeability. *See* Microvascular permeability, endotoxemia/septic shock

## Vascular resistance

ETX, cause of mediator release in sepsis peripheral, 377, 381, 382, 385

systemic, 377

ibuprofen and ETX-stimulated inflammation, 337, 338, 340, 344

multitherapy regimen for endotoxemia, hemodynamics, 216, 218, 219, 230

pulmonary

- multitherapy regimen for endotoxemia, hemodynamics, 218, 220, 230, 231
- PGE1 administration in ARDS, 363, 365-367
- systemic, ETX shock (*E. coli*), dog model, 396, 397
- trypsin-induced shock, hemodynamics and proteolysis, 190, 191
- Vascular tone, physiologic-metabolic correlations, septic shock, 442, 444
- Vasopressin, 382, 601
  - transmembrane signaling perturbation, endotoxemia, rat hepatocyte, 402, 404, 407-412, 415
  - receptors, 405-406, 415
- Vena cava superior, lung monitoring during CPB, 96-98, 101, 102, 104
- Ventilatory management
  - inhalation injury, burn shock and resuscitation, 551
  - physiologic-metabolic correlations, septic shock, 455
- Ventricular performance
  - hypovolemic-traumatic shock, 561, 567
  - multitherapy regimen for endotoxemia, 230, 231, 233
  - myocardial dysfunction in sepsis, 573, 577, 579, 581, 582
    - compliance, 581
  - physiologic-metabolic correlations in septic shock, 444
- Verapamil, 581, 583, 584
  - burn shock and resuscitation, 542
- White blood cells. *See* Leukocyte(s); specific types
- Wound. *See* Multiple organ failure, wound inflammatory mediators
- Xanthine oxidase, 260
- ZAP, 166-168