

Artificial Liver Support

Edited by G. Brunner and F.W. Schmidt



Springer-Verlag Berlin Heidelberg New York

Artificial Liver Support

Edited by

G. Brunner and F. W. Schmidt

With 156 Figures and 69 Tables

Springer-Verlag
Berlin Heidelberg New York 1981

Professor Dr. Gorig Brunner
Medizinische Hochschule Hannover
Abteilung für Gastroenterologie und Hepatologie
Krankenhaus Oststadt, Podbielskistr. 380
3000 Hannover 51, FRG

Professor Dr. Friedrich Werner Schmidt
Medizinische Hochschule Hannover
Abteilung für Gastroenterologie und Hepatologie
Karl-Wiechert-Allee 9
3000 Hannover 61, FRG

Proceedings of an International Symposium held in Celle,
Germany, June 2-4, 1980

ISBN 3-540-10591-3 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-10591-3 Springer-Verlag New York Heidelberg Berlin

Library of Congress Cataloging in Publication Data. Main entry under title: Artificial liver support. Proceedings of an international symposium, held in Celle, Germany, June 2-4, 1980. Bibliography: p. Includes index. I. Artificial liver--Congresses. I. Brunner, G. (Gorig), 1939-II. Schmidt, F. W. (Friedrich Werner), 1926-. RC846.A76 617'.556 81-4931 AACR2

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically those of translation, reprinting, re-use of illustrations, broadcasting, reproduction by photocopying machine or similar means, and storage in data banks. Under § 54 of the German Copyright Law where copies are made for other than private use a fee is payable to "Verwertungsgesellschaft Wort", Munich.

© Springer-Verlag Berlin Heidelberg 1981
Printed in Germany

The use of general descriptive names, trade marks, etc. in this publication, even if the former are not especially identified, is not to be taken as a sign that such names, as understood by the Trade Marks and Merchandise Marks Act, may accordingly be used freely by anyone.

Printing: Beltz Offsetdruck, Hemsbach/Bergstr.; Bookbinding: J. Schäffer OHG, Grünstadt 2121/3140-543210

Preface

The regenerative capacity of the liver cell is almost unlimited. Therefore after acute liver damage, be it viral, toxic, hypoxic, or surgical in origin, restitutio ad integrum is the usual outcome. In two forms of liver disease, however, this is not the case: in fulminant hepatic failure, liver regeneration often is not fast enough to keep the organism alive; in end-stage cirrhosis, regeneration is disturbed by a hypertrophic architecture of fibrotic tissue. For these extreme forms of liver disease and for critical situations before and after liver surgery, artificial liver support is needed.

This book contains the latest results in this area of research presented by scientists from all over the world at an international symposium held in Celle, Germany, June 2-4, 1980.

Exciting new methods like continuous membrane plasma separation and liver cell transplantation into the spleen have been developed. The older methods of hemoperfusion and dialysis have been improved. Enzymological methods and liver transplantation have made good progress. We hope that this volume will help the clinician in his decision-making and stimulate ingenious new research for the benefit of our liver patients.

G. Brunner
F.W. Schmidt

The Symposium was made possible by contributions of the following companies:

Asahi Medical, Tokyo
Bayer AG., Leverkusen
Behringwerke AG., Marburg
Biostest-Serum-Institut GmbH, Frankfurt
Boehringer Mannheim GmbH, Mannheim
B. Braun Melsungen AG., Melsungen
Byk Gulden, Konstanz
Chemiewerk Homburg, Frankfurt
Deutsche Wellcome GmbH, Burgwedel
ENKA Glanzstoff AG, Wuppertal-Barmen
Dr. Falk GmbH & Co, Freiburg
Dr. E. Fresenius, Bad Homburg v.d.H
Gödeke AG, Berlin
Grünenthal GmbH, Stolberg
Ludwig Heumann & Co, GmbH, Nürnberg
Hoechst AG, Frankfurt
Hospal Medizin Technik, Nürnberg
Immuno GmbH, Heidelberg
Janssen GmbH, Heidelberg
Kali Chemie AG., Hannover
Knoll AG., Ludwigshafen/Rhein
Dr. Madaus & Co, Köln
Paul Martini Stiftung e.V., Mainz
Pfizer GmbH, Karlsruhe
Röhm Pharma GmbH, Darmstadt
Sartorius GmbH, Göttingen
Smith and Nephew Pharmaceutical Limited, Hertfordshire, England
Smith Kline Dauelsberg GmbH & Co, Göttingen
Zuckerraffinierie Tangermünde GmbH, Hamburg

List of Contributors

- Anhalt, E., Dipl. Chem., Med. Hochschule Hannover, Inst. für Klin. Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Asanuma, Y., Dr., Dept. of Artificial Organs, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, Ohio 44106, USA
- Bantjes, A., Prof. Dr., Department of Chemical Technology, Biomaterials Section, Twente University, PO Box 217, Enschede, The Netherlands
- Bartels, O., Priv.-Doz. Dr., Med. Klinik und Poliklinik, Krankenhausstr. 12, 8520 Erlangen, FRG
- Batavier, P., Academisch Ziekenhuis Rotterdam, Dr. Molewaterplein 40, Rotterdam – 3002, The Netherlands
- Blümel, G., Dr., Chir. Klinik und Poliklinik rechts der Isar der Techn. Universität München, Ismaninger Str. 22, 8000 München 80, FRG
- Blumgart, L.H., Dr., Med. Universitätsklinik, Rostock, GDR
- Bohannon, J., College of Engineering, Univ. of Oklahoma, 202 West Boyd, Room 23, Norman, Oklahoma 73019, USA
- Boot, J., Mr., Department of Internal Medicine II, University Hospital Dijkzigt, Rotterdam, The Netherlands
- Boniolo, A., Dr., Sorin Biomedica, 13040 Saluggia (Vercelli), Italy
- Bottermann, P., Prof. Dr., Med. Klinik, Universität München, Ismaninger Str. 22, 8000 München 80, FRG
- Brandes, J.M., Prof. Dr., Technion-Israel, Inst. of Technology, Dept. of Chemical Engineering, Haifa, Israel
- Brinson, L., College of Engineering, Univ. of Oklahoma, 202 West Boyd Room 23, Norman, Oklahoma 73019, USA
- Broelsch, Ch.E., Priv.-Doz. Dr., Med. Hochschule Hannover, Dept. Chirurgie, Abt. für Abdominal- u. Transplantationschirurgie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG

- Brunner, G., Professor Dr., Med. Hochschule Hannover, Abt. f.
Gastroenterologie und Hepatologie, Krankenhaus Oststadt,
Podbielskistr. 380, 3000 Hannover 51, FRG
- Burdelski, M., Dr., Klinik für Abdominal- und Transplantations-
chirurgie und Kinderklinik der Medizinischen Hochschule
Hannover, FRG
- Callegaro, L., Dr., Sorin Biomedica, 13040 Saluggia (Vercelli), Italy
- Calne, R.Y., Prof. Dr., Univ. of Cambridge Clinical School,
Dept. of Surgery, Addenbrookes Hospital, Hills Road,
Cambridge CB2 2QQ, England
- Canalese, J., Dr., Liver Unit, King's College Hospital, Denmark
Hill, London SE5 9RS, England
- Carey, W., Dr., Dept. of Artificial Organs, Cleveland Clinic,
9500 Euclid Avenue, Cleveland, Ohio 44106, USA
- Chamuleau, R.A.F.M., Dr., Department of Internal Medicine,
„Binnengasthuis“, Grimborgwal 10, University of Amsterdam,
The Netherlands
- Chang, T.M.S., Prof. Dr., McGill University, 3655 Drummond
Street, Montreal, PQ, Canada H3A 1Y6
- Courtney, J.M., Dr., University of Strathclyde, Bioengineering
Unit, Wolfson Centre, 106 Rottenrow, Glasgow, Scotland
- Czygan, P., Priv.-Doz. Dr., Med. Klinik, Univ. Heidelberg,
Abt. Gastroenterologie, Bergheimer Str. 58, 6900 Heidelberg,
FRG
- Denti, E., Dr., Sorin Biomedica, 13040 Saluggia (Vercelli), Italy
- Dreyer, C., cand. med., Med. Hochschule Hannover, Inst. für klin.
Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Ebata, H., Dr., Asahikawa Medical College, Nishi-kagura
Asahikawa, Hokkaido, 078-11, Japan
- Eckert, G., Med. Hochschule Hannover, Inst. f. klin.
Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Eisenbach, G.M., Prof. Dr., Med. Hochschule Hannover, Abt. f.
Nephrologie, Krankenhaus Oststadt, Podbielskistr. 380,
3000 Hannover 51, FRG
- Erhardt, W., Dr., Chir. Klinik u. Poliklinik rechts der Isar der
Tech. Univ. München, Ismaninger Str. 22, 8000 München 80,
FRG
- Fennimore, J., Smith and Nephew Research Ltd., Gilston Park,
Harlow, Essex CM20 2RQ, England

Fischer, M., Priv.-Doz. Dr., Chir. Klinik u. Poliklinik rechts der Isar der Techn. Univ. München, Ismaninger Str. 22, 8000 München 80, FRG

Fishler, L.S., Dr., Technion-Israel, Inst. of Technology, Dept. of Chemical Engineering, Haifa, Israel

Fontana, A., Prof. Dr., Sorin Biomedica, 13040 Saluggia (Vercelli), Italy

Fraunhofer, B., Dr., Chir. Klinik u. Poliklinik rechts der Isar der Techn. Univ. München, Ismaninger Str. 22, 8000 München 80, FRG

Gaub, J., Dr., Medical Department A, Division of Hepatology, The University Hospital 9, Blegdamsvej, 2100 Copenhagen, Denmark

Gimson, A.E., Liver Unit, King's College Hospital, Denmark Hill, London SE5 9RS, England

Goubeaud, G., Dr., Zentrum f. Innere Medizin am Klinikum der Justus-Liebig-Univ., Klinikstr. 36, 6300 Lahn-Giessen, FRG

de Groot, G.H., Dr., Academisch Ziekenhuis Rotterdam, Dr. Molewaterplein 40, Rotterdam-3002, The Netherlands

Grünn, U., Dr., Chir. Univ. Klinik u. Poliklinik, Sigmund-Freud-Str. 25, 5300 Bonn, FRG

Gundermann, K.J., Dr., Chir. Univ. Klinik u. Poliklinik, Sigmund-Freud-Str. 25, 5300 Bonn, FRG

Haeger, I., Med. Hochschule Hannover, Inst. für klin. Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG

Hammersmith D., Dr., Dept. of Artificial Organs, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, Ohio 44106, USA

Häring, R., Prof. Dr., Freie Univ. Berlin, Universitätsklinikum Steglitz, Hindenburgdamm 30, 1000 Berlin 45, Germany

Harstick, K., cand. med., Abt. f. Gastroenterologie u. Hepatologie, Med. Hochschule Hannover, Oststadtkrankenhaus, Podbielskistr. 380, 3000 Hannover 51, FRG

Holloway, C.J., Dr. phil., Med. Hochschule Hannover, Inst. für klin. Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG

Horak, W., Priv.-Doz. Dr., Univ. Klinik für Gastroenterologie und Hepatologie, Garnisionsgasse 13, 1090 Wien, Austria

van Horn-Hickmann, R., Dr., University of Cape Town, Medical School, Observatory 7900 Cape Town, South Africa

- Hughes, R., Dr., King's College Hospital, Denmark Hill, London SE5 9RS, England
- Inoue, N., Dr., Dept. of Internal Medicine, Oji National Hospital, Akabanedai 4-17-56, Kita, Tokyo, Japan
- Inoue, T., Dr., Dept. of Internal Medicine, Oji National Hospital, Akabanedai 4-17-56, Kita, Tokyo, Japan
- Jones, E.A., Dr., Dept. of Health, Education, and Welfare, National Inst. of Health, Bethesda, Maryland 20205, USA
- de Jonge, M., Dr., Department of Internal Medicine II, University Hospital Dijkzigt, Rotterdam, The Netherlands
- Kahn, D., Dr., Univ. of Cape Town, Medical School, Observatory 7900, Cape Town, South Africa
- Kamiyama Y., Dr., Dept. of Surgery, Kyoto Univ. Medical School, 54 Kawara-Cho, Shogoin, Sakyo-ku, Kyoto, Japan 606
- Kim, B.R., Dr., Chir. Univ. Klinik u. Poliklinik, Sigmund-Freud-Str. 25, 5300 Bonn, FRG
- Kimura, K., Dr., Chir. Univ. Klinik u. Poliklinik, Sigmund-Freud-Str. 25, 5300 Bonn, FRG
- Klausmann, J., Dr., Zentrum f. Innere Medizin am Klinikum der Justus-Liebig-Univ., Klinikstr. 36, 6300 Lahn-Giessen, FRG
- Klinkmann, H., Prof. Dr., Med. Universitätsklinik Rostock, GDR
- Knell, A.J., Dr., Warwick Hospital, Lakin Road, Warwick CV34 5BW, England
- Kommerell, B., Prof. Dr., Med. Klinik, Univ. Heidelberg, Bergheimer Str. 58, 6900 Heidelberg, FRG
- de Koning, H.W.M., Dr., Department of Chemical Technology, Biomaterials Section, Twente University, PO Box 217, Enschede, The Netherlands
- Kuntz, M., Med. Hochschule Hannover, Inst. f. klin. Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Kusano, M., Dr., Asahikawa Medical College, Nishi-kagura Asahikawa, Hokkaido, 078-11, Japan
- Lang, S.M., Smith and Nephew Research Ltd., Gilston Park, Harlow, Essex CM20 2RQ, England
- Langley, P.G., Dr., Liver Unit, King's College Hospital, Denmark Hill, London SE5 9RS, England

- Lanzinger, L., Dr., Med. Univ. Klinik Heidelberg, Bergheimer Str. 58, 6900 Heidelberg, FRG
- Leber, H.W., Prof. Dr., Zentrum f. Innere Medizin am Klinikum der Justus-Liebig-Univ., Klinikstr. 36, 6300 Lahn-Giessen, FRG
- Lens, P., Dr., Academisch Ziekenhuis Rotterdam, Dr. Molewaterplein 40, Rotterdam-3002, The Netherlands
- Levy, V.G., Dr., Centre Hospitalier Universitaire Saint-Antoine, 184, Rue Faubourg Saint-Antoine, 75012 Paris, France
- Lie, T.S., Prof. Dr., Chir. Universitätsklinik Bonn, Venusberg, 5300 Bonn, FRG
- Limberg, B., Dr., Klinikum der Univ. Heidelberg, Med. Klinik, Bergheimer Str. 58, 6900 Heidelberg, FRG
- Lösgen, H., Dr., Med. Hochschule Hannover, Abt. f. Gastroenterologie und Hepatologie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Malchesky, P., Dr., Dept. of Artificial Organs, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, Ohio 44106, USA
- Malinverni, A., Dr., Sorin Biomedica, 13040 Saluggia (Vercelli), Italy
- Matthews, A., Dr., College of Engineering, Univ. of Oklahoma, 202 West Boyd, Room 23, Norman, Oklahoma 73019, USA
- Mito, M., Prof. Dr., Asahikawa Medical College, Nishi-kagura Asahikawa, Hokkaido, 078-11 Japan
- Mor, L., Dr., Technion-Israel, Inst. of Technology, Dept. of Chemical Engineering, Haifa, Israel
- Neidhardt, M., Dr., Med. Klinik u. Poliklinik, Krankenhausstr. 12, 8520 Erlangen, FRG
- Neuhaus, P., Dr., Med. Hochschule Hannover, Dept. Chirurgie, Abt. für Abdominal- und Transplantationschirurgie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Neumann, E., Med. Hochschule Hannover, Abt. f. Gastroenterologie u. Hepatologie, Krankenhaus Oststadt, Podbielskistr. 380, 3000 Hannover 51, FRG
- Nosé, Y., Prof. Dr., Dept. of Artificial Organs Cleveland Clinic, 9500 Euclid Avenue, Cleveland, Ohio 44106, USA
- Oberdorfer, A., Prof. Dr., Institute of Clinical Chemistry and Pathobiochemistry, Technical University of Munich, FRG

- Oda, T., Dr., Dept. of Internal Medicine, Oji National Hospital,
Akabanedaj 4-17-56, Kita, Tokyo, Japan
- Okada, K., Dr., Oji National Hospital and University of Tokyo
Hospital, Akabanedai 4-17-56, Kita, Tokyo, Japan
- Olek, K., Dr., Chir. Univ. Klinik, 5300 Bonn, FRG
- Onishi, T., Dr., Asahikawa Medical College, Nishi-kagura
Asahikawa, Hokkaido, 078-11, Japan
- Opolon, P., Prof. Dr., Centre Hospitalier Universitaire
Saint-Antoine, 184, Rue Faubourg Saint-Antoine, 75012 Paris,
France
- Ozawa, K., Dr., Dept. of Surgery, Kyoto Univ. Medical School,
54 Kawara-Cho, Shogoin, Sakyo-ku, Kyoto, Japan 606
- Parzinger, G., Dr., Chir. Univ. Klinik rechts der Isar der Techn.
Univ. München, Ismaninger Str. 22, 8000 München 80, FRG
- Pichlmayr, R., Prof. Dr., Med. Hochschule Hannover, Dept.
Chirurgie, Abt. für Abdominal- und Transplantationschirurgie,
Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Podehl, D., cand. med., Med. Hochschule Hannover, Abt. für
klin. Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61,
FRG
- Poetsch, R., Dr., Lindenstr. 33, 6072 Dreieichl, FRG
- Popper, H., Prof. Dr., The Mount Sinai School of Medicine,
100th Street and 5th Avenue, New York, N.Y. 10029, USA
- Rakette, S., Dr., Chir. Klinik u. Poliklinik rechts der Isar der
Techn. Univ. München, Ismaninger Str. 22, 8000 München 80,
FRG
- Ranek, L., Dr., Medical Department A, Division of Hepatology,
The University Hospital, 9, Blegdamsvej, 2100 Copenhagen,
Denmark
- Rasche, A., Dr., Chir. Univ. Klinik Bonn, Venusberg, 5300 Bonn,
FRG
- Rooke, L., Mr., Department of Internal Medicine II, University
Hospital Dijkzigt, Rotterdam, The Netherlands
- Rolles, K., Dr., Dept. of Surgery, University of Cambridge,
Addenbrooke's Hospital, Cambridge CB2 2QQ, England
- Ryan, C.J., Dr., Univ. of Strathclyde, Bioengineering Unit,
Wolfson Centre, 106 Rottenrow, Glasgow, Scotland

- Sakai, T., Dept. of Internal Medicine, Oji National Hospital,
Akabane-dai 4-17-56, Kita, Tokyo, Japan
- Sanjo, K., Dr., Dept. of Internal Medicine, Oji National Hospital,
Akabane-dai 4-17-56, Kita, Tokyo, Japan
- Schafer, D.F., Dr., Dept. of Health, Education, and Welfare,
National Inst. of Health, Bethesda, Maryland 20205, USA
- Schalm, S.W., Dr., Academisch Ziekenhuis Rotterdam,
Dr. Molewaterplein 40, Rotterdam-3002, The Netherlands
- Schellberger, H., Dr., Med. Klinik u. Poliklinik, Krankenhausstr. 12,
8520 Erlangen, FRG
- Schicht, I., Dr., Academisch Ziekenhuis Rotterdam,
Dr. Molewaterplein 40, Rotterdam-3002, The Netherlands
- Schleicher, P., Dr., Chir. Klinik u. Poliklinik rechts der Isar der
Techn. Univ. München, Ismaninger Str. 22,
8000 München 80, FRG
- Schmidt, E., Prof. Dr., Med. Hochschule Hannover, Abt. für
Gastroenterologie und Hepatologie, Karl-Wiechert-Allee 9,
3000 Hannover 61, FRG
- Schmidt, F.W., Prof. Dr., Med. Hochschule Hannover, Abt. f.
Gastroenterologie und Hepatologie, Karl-Wiechert-Allee 9,
3000 Hannover 61, FRG
- Schügerl, K., Prof. Dr., Inst. f. Technische Chemie der Univ.
Hannover, Callinstr. 6, 3000 Hannover 1, FRG
- Sederel, L.C., Dr., Department of Chemical Technology,
Biomaterials Section, Twente University, PO Box 217,
Enschede, The Netherlands
- Sideman, S., Prof. Dr., Technion-Israel, Inst. of Technology,
Dept. of Chemical Engineering, Haifa, Israel
- Sieg, A., Dr., Med. Klinik, Univ. Heidelberg, Bergheimer Str. 58,
6900 Heidelberg, FRG
- Sofer, S., Prof. Dr., College of Engineering, Univ. of Oklahoma,
202 West Boyd, Room 23, Norman, Oklahoma 73019, USA
- v. Sommogyi, St., Dr., Chir. Klinik, II. Med. Klinik, Univ. München,
Ismaninger Str. 22, 8000 München 80, FRG
- Stevens, B., College Of Engineering, Univ. of Oklahoma,
202 West Boyd, Room 23, Norman, Oklahoma 73019, USA
- Stiehl, A., Med. Klinik, Univ. Heidelberg, Bergheimer Str. 58,
6900 Heidelberg, FRG

- Tegtmeier, F., Dipl. Chem., Med. Hochschule Hannover, Abt. f.
Gastroenterologie und Hepatologie, Oststadtkrankenhaus,
Podbielskistr. 380, 3000 Hannover 51, FRG
- Terblanche, J., Prof. Dr., University of Cape Town, Dept. of
Surgery Medical School, Observatory 7900, Cape Town,
South Africa
- Terpstra, J.L., Prof. Dr., Academisch Ziekenhuis Rotterdam,
Dr. Molewaterplein 40, Rotterdam-3002, The Netherlands
- Thaler, I., Dr., Technion-Israel, Inst. of Technology, Dept. of
Chemical Engineering, Haifa, Israel
- Tidow, G., Dr., Med. Hochschule Hannover, Dept. Chirurgie, Abt.
f. Abdominal- u. Transplantationschirurgie, Karl-Wiechert-
Allee 9, 3000 Hannover 61, FRG
- Tobe, T., Dept. of Surgery, Kyoto University Medical School,
54 Kawara-Cho, Shogoin, Sakyo-ku, Kyoto, Japan 606
- Trautschold, I., Prof. Dr., Med. Hochschule Hannover, Abt. f. Klin.
Biochemie, Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Tystrup, N., Prof. Dr., Medical Department A, Division of
Hepatology, The University Hospital, 9, Blegdamsvej,
2100 Copenhagen, Denmark
- Tung, L.C., Priv.-Doz. Dr., Chir. Klinik u. Poliklinik, Univ.
Klinikum Steglitz, Hindenburgdamm 30, 1000 Berlin, Germany
- Uhlhaas, S., Dr., Chir. Klinik u. Poliklinik, Univ. Bonn,
Venusberg, 5300 Bonn, FRG
- Ukikusa, M., Dept. of Surgery, Kyoto Univ. Medical School,
54 Kawara-Cho, Shogoin, Sakyo-ku, Kyoto, Japan 606
- Völkel, W., Dr., Inst. f. Techn. Chemie der Univ. Hannover,
Callinstr. 6, 3000 Hannover 1, FRG
- Wada, T., Dr., Dept. of Internal Medicine, Oji National Hospital,
Akabanedai 4-17-56, Kita, Tokyo, Japan
- Waggoner, J.G., Dr., Dept. of Health, Education, and Welfare,
National Inst. of Health, Bethesda, Maryland 20205, USA
- Waldschmidt, J., Dr., Chir. Klinik u. Poliklinik, Univ. Klinikum
Steglitz, Hindenburgdamm 30, 1000 Berlin, Germany
- Walker, S., Med. Univ. Klinik, Univ. Heidelberg,
Bergheimer Str. 58, 6900 Heidelberg, FRG
- Weber, D., Dr., Chir. Klinik u. Poliklinik, Univ. Klinikum
Steglitz, Hindenburgdamm 30, 1000 Berlin, Germany

- van Wie, B., College of Engineering, Univ. of Oklahoma,
202 West Boyd, Room 23, Norman, Oklahoma 73019, USA
- Williams, R., Dr., Liver Unit, King's College Hospital, Denmark
Hill, London SE5 9RS, England
- Wills, R., College of Engineering, Univ. of Oklahoma,
202 West Boyd, Room 23, Norman, Oklahoma 730129, USA
- Windus, G., Med. Hochschule Hannover, Abt. f. Gastroenterologie
u. Hepatologie, Oststadtkrankenhaus Hannover, Podbielskistr.
380, 3000 Hannover 51, FRG
- Wolf, C.F.W., Dr., Lindsley F. Kimball, Research Institute, The
New York Blood Center, 310 East 67th Street, New York
City, N.Y. 10017, USA
- Wonigeit, K., Dr., Med. Hochschule Hannover, Dept. Chirurgie,
Abt. f. Abdominal- u. Transplantationschirurgie,
Karl-Wiechert-Allee 9, 3000 Hannover 61, FRG
- Yamasaki, Z., Dr., Dept. of Internal Medicine, Oji National
Hospital, Akabaneidai 4-17-56, Kita, Tokyo, Japan
- Yoshiba, M., Dr., Dept. of Internal Medicine, Oji National
Hospital, Akabaneidai 4-17-56, Kita, Tokyo, Japan
- Zeneroli, M.L., Dr., Instituto di Semeiotica Medica, Universita di
Modena, Via del Pozzo, 41100 Modena, Italy
- Zieve, I., Prof. Dr., Department of Medicine, Hennepin Medical
Center, 701 Park Avenue South, Minneapolis, Minnesota
55415, USA

Contents

I. General Aspects of Hepatic Failure

H. Popper

Mechanism of Liver Cell Destruction in Fulminant Hepatic Failure 1

E. Schmidt and F.W. Schmidt

Enzyme Patterns in Liver Failure 8

L. Zieve

Synergism Among Toxic Factors and Other Endogenous Abnormalities in Hepatic Encephalopathy 18

G. Brunner, G. Windus, and H. Lösgen

On the Role of Free Phenols in the Blood of Patients in Hepatic Failure 25

C.J. Holloway

The Biochemistry of Hepatic Detoxification 32

N. Tygstrup, J. Gaub, and L. Ranek

Determination of Liver Function and Liver Regeneration in Fulminant Hepatic Failure 39

II. Hemoperfusion

S.M. Lang and J. Fennimore

The Development of a Haemoperfusion Device for Chronic Use 46

K.J. Gundermann, K. Kimura, S. Uhlhaas, K. Olek and T.S. Lie
A New Charcoal Sorbent Fiber for Hemoperfusion 55

C.J. Holloway, G. Brunner, and K. Harstick

Agarose-Encapsulated Adsorbents

I. Concept and General Properties 66

C.J. Holloway, M. Kuntz, and D. Podehl

Agarose-Encapsulated Adsorbents

II. Adsorption Characteristics 72

- C. Dreyer, G. Eckert, I. Haeger, and C.J. Holloway*
Agarose-Encapsulated Adsorbents
III. In Vitro Haemocompatibility 76
- H.W.M. de Koning, R.A.F.M. Chamuleau, L.C. Sederel, and A. Bantjes*
Coating and Blood Compatibility of Amberlite XAD-4 82
- R.D. Hughes and R. Williams*
Development of a Blood-Compatible Resin for Artificial Liver Support 89
- H.W. Leber, J. Klausmann, G. Goubeaud, and G. Schütterle*
Middle Molecules in the Serum of Patients and Rats with Liver Failure: Influence of Sorbent Haemoperfusion 96
- S. Sideman, L. Mor, L.S. Fishler, I. Thaler, and J.M. Brandes*
Bilirubin Removal by Sorbent Hemoperfusion from Jaundiced Blood 103
- W. Horak*
Removal of Bile Acids by Various Means of Artificial Liver Support 110
- A.E.S. Gimson, J. Canalese, P.G. Langley, R.D. Hughes, and R. Williams*
Charcoal Haemoperfusion with PGI₂ in the Treatment of Fulminant Hepatic Failure 115
- O. Bartels, M. Neidhardt, and H. Schellberger*
Hormone Losses by Charcoal Hemoperfusion 121
- T.M.S. Chang*
Hemoperfusion, Exchange Transfusion, Cross Circulation, Liver Perfusion, Hormones and Immobilized Enzymes 126
- C.J. Ryan, J.M. Courtney, H. Klinkmann, and L.H. Blumgart*
Partial Hepatectomy and Subsequent Charcoal Hemoperfusion in the Conscious Rat 134
- III. Dialysis Procedures**
- P. Opolon*
Large-Pore Hemodialysis in Fulminant Hepatic Failure 141
- A.J. Knell*
Haemodialysis Procedures in Acute Liver Failure 147
- H. Lösgen, E. Neumann, G. Eisenbach, F.W. Schmidt, and G. Brunner*
Correction of Increased Plasma Amino Acid Levels by Dialysis with Amino Acid-Electrolyte-Glucose Solutions 153

- G.H. de Groot, S.W. Schalm, J. Boot, I. Schicht, P. Batavier, L. Rooke, M. de Jonge, J. Lens, and J.L. Terpstra*
Hemofiltration in Acute Liver Failure: Substitution with Electrolyte Solution Versus Normal Animal Ultrafiltrate 159

- K. Ozawa, Y. Kamiyama, M. Ukiyusa, and T. Tobe*
Significance of Hepatic Energy Charge and Blood Ketone Body Ratio as Criteria of Liver Support. Indication and Efficiency in Hepatectomized Patients During Cross Dialysis 164

IV. Amino Acid Level Concentration

P. Czygan, S. Walker, A. Sieg, A. Stiehl, L. Lanzinger, and B. Kommerell

Effect of Liver Adapted Amino Acids on Portosystemic Encephalopathy in Patients with Cirrhosis of the Liver and Portosystemic Shunts 170

B. Limberg and B. Kommerell

Somatostatin: A New Therapeutic Agent for Treatment of Hepatic Encephalopathy? 172

V. Plasmapheresis

N. Inoue, M. Yoshioka, Z. Yamazaki, T. Sakai, K. Sanjo, K. Okada, T. Oda, T. Wada, and T. Inoue

Continuous Flow Membrane Plasmapheresis Utilizing Cellulose Acetate Hollow Fiber in Hepatic Failure 175

Y. Nosé, P. Malchesky, and Y. Asanuma

Augmented Solute Reduction in Diseases Treated by Extracorporeal Detoxification Systems: X-Effect Hypothesis 181

M.L. Zeneroli, D.F. Schafer, J. G. Waggoner, and E.A. Jones
Hemoperfusion-Induced Respiratory Distress Syndrome in an Animal Model: The Effects of Corticosteroids 189

VI. Enzymatic Support

L. Callegaro, E. Denti, and A. Fontana

Immobilized Hepatic Enzymes as a Tool in Extracorporeal Detoxification 198

L. Callegaro, A. Boniolo, and A. Malinverni

Immobilization of Ligandin on Hollow Fiber Reactors 202

E. Anhalt, C.J. Holloway, G. Brunner, and I. Trautschold

Detoxification of Phenols by Sulphate Conjugation: An Alternative to Glucuronidation in an Enzymatic Liver Support System 208