Perinatology

Evidence-Based Best Practices in Perinatal Medicine

Renato Augusto Moreira de Sá
Eduardo Borges da Fonseca
Editors

Springer

Perinatology

Renato Augusto Moreira de Sá •
Eduardo Borges da Fonseca
Editors

Perinatology

Evidence-Based Best Practices in Perinatal Medicine

Springer

Editors
Renato Augusto Moreira de Sá
Maternal and Child Department
Fluminense Federal University
Niterói, Rio de Janeiro
Brazil

Eduardo Borges da Fonseca
Federal University of Paraíba
João Pessoa, Paraíba
Brazil

ISBN 978-3-030-83433-3 ISBN 978-3-030-83434-0 (eBook)
https://doi.org/10.1007/978-3-030-83434-0

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

Rodrigo, Alice, and Isadora, our children and our hope for a better world.

Foreword

As one of the founders of perinatal medicine, it is my particular pleasure to write this foreword and to support the current activities in this fascinating new field of human medicine.

A particular highlight is to do it together with Ana Bianchi, the scientific daughter of my old friend and supporting pioneer in fetal medicine Roberto Caldeyro-Barcia from Uruguay. He in heaven and I still on earth are grateful to the younger, currently so active, and successful generation for continuing what we started and founded decades ago.

Perinatal medicine is very versatile because its main part, the prenatal block – this means everything that happens before birth – was to a high degree, up to the beginning of the 1960s, a medically unexplored space. In the meantime, the evolution has been explosive.

Perinatal medicine is subject to its special characteristics, namely to be interdisciplinary. This means that the cooperation with other important disciplines should be essential. The closest connection exists between obstetrics and neonatology in advanced centres even more than between obstetrics and gynecology.

I wish good success.

Erich Saling
"Professor Emeritus" of Perinatal Medicine at the Charité,
Humboldt-University Berlin - Germany
The Father of Perinatal Medicine

Ana Bianchi
President of Caldeyro-Barcia Foundation - Uruguay

Preface

Perinatal period is defined as *"the period of time between 22 weeks after fertilization and 7 days after parturition."*[1]

Usually, authors specializing in obstetrics and maternal-fetal medicine are invited to write chapters of perinatology books and to express themselves about problems related to perinatology. Consequently, the set of written productions includes strictly obstetric texts, most often intended for prenatal care, or works written by pediatricians and intended for neonatal care.

At the development stage of this book, our desire was to follow the idea of Erich Saling from the book ***The Child in the Field of Obstetrics*** (Das Kind im Bereich der Geburtshilfe) [2]. In the 1950s, "The Father of Perinatal Medicine," exhorts the antenatal care importance, reinforcing the innovative achievement of another pioneer on perinatal care, Roberto Caldeyro-Barcia.

The progressive specialization in the field of medicine has led us to bring two specialties, materno-fetal medicine and neonatology. The improvement in the assessment of fetal well-being and *in-utero* treatment and the advancements in neonatal intensive care have greatly improved the chances of babies' long-term survival. Therefore, to avoid unnecessary confusion for the purposes of this book, the perinatal period will be extended from 20 completed weeks (140 days) of gestation to 28 completed days after birth. This extended definition is accepted by many authors and medical specialty societies.

Keeping in mind the original proposal of the pioneers of perinatology, which correspond with our convictions, we accepted the invitation of Springer to bring together in this book renowned authors of the two great specialties involved in the field of perinatology: obstetrics and neonatology.

[1] 1. World Health Organization. ICD-11 for mortality and morbidity statistics. Version: 2020 September. Available from: https://icd.who.int/browse11/l-m/en#/http://id.who.int/icd/entity/914150644. Assessed in February 2021.

[2] Dudenhausen JW. Erich Saling - The Father of Prenatal and Perinatal Medicine-Dedication to his 90th birthday. J Perinat Med. 2015 Jul;43(4):379.

This work was not without its difficulties. The main one comes from the fact that this type of book organization gathers varied chapters in form and content, and is at risk of becoming a "patchwork" that leaves the reader disoriented.

Such inconvenience was overcome by the editors, who were careful to put the texts in consistent thematic blocks, managing to make the book reflect the themes related to pediatrics and obstetrics in an integrated way to allow a better understanding of perinatology. So, our aim was to avoid transmitting an overly integrated and closed view of one of the specialties, leaving to our reader space for their own reflection on the themes and for the development of self-interpretations.

We are grateful to chapter authors and the support by the notable Professors Erich Saling, Asim Kurjak, and Ana Bianchi.

We dedicate this book to our children Rodrigo, Alice, and Isadora, who are the biggest motivation of our lives.

Rio de Janeiro, RJ, Brazil — Renato Augusto Moreira de Sá
Niteroi, RJ, Brazil
João Pessoa, Paraíba, Brazil — Eduardo Borges da Fonseca

Acknowledgement

Prof Asim Kurjak, for supporting the Perinatal Medicine activities all around the world.

Contents

Part I Periconceptional Care

1 Historical Preface: Early Stages of Perinatal Medicine 3
Erich Saling and Jürgen Lüthje

2 Professional Ethics in the Clinical Practice of Perinatal Medicine 15
Frank A. Chervenak and Laurence B. McCullough

3 Guidance and Assessment of Preconception Risk 25
Amos Grunebaum, Joachim Dudenhausen, and Frank A. Chervenak

4 Genetics for the Obstetrician: Bases of Genetic Counseling 37
Regina Amélia Lopes Pessoa de Aguiar and Marcos José Burle de Aguiar

5 Screening for Chromosomal Anomalies 45
Fabrício da Silva Costa and Conrado Sávio Ragazini

6 Protocol of Immunization of the Adult Woman 55
Julio Cesar Teixeira

7 Drugs in Pregnancy and Childbirth 63
Fernando Barbosa Peixoto, Eduardo Carvalho de Arruda Veiga, and Ricardo Carvalho Cavalli

Part II Prenatal Care

8 Nutritional Aspects of Gestation and Puerperium 77
Cláudia Saunders and Karina dos Santos

9 Physical Exercise During Pregnancy 147
Antonio Claudio Lucas da Nóbrega and Renata Rodrigues Teixeira de Castro

10 Standards In Prenatal Care 157
Fernanda Campos da Silva and Gustavo Mourão Rodrigues

11 Multiple Pregnancy 171
Carolina Carvalho Mocarzel and Ana Carla Zanchietta Nicolielo

Part III Fetal Proceedings

12 Ultrasound 193
Alberto Borges Peixoto and Edward Araujo Júnior

13 Clinical Use of 3D Sonography 221
Asim Kurjak and Lara Spalldi Barišić

14 First-Trimester Ultrasonography 273
Fernando Maia Peixoto-Filho
and Paulo Roberto Nassar de Carvalho

15 Ultrasound in Second and Third Trimester: What Should Be Evaluated? 285
Victor Rocha de Castro Alves, Rafaela Cardoso Gil Pimentel,
Augusto César Garcia Saab Benedeti, and Francisco Mauad Filho

16 Doppler Velocimetry 295
Cristos Pritsivelis, Jair Roberto da Silva Braga,
and Jorge de Rezende-Filho

17 Antepartum Cardiotography 303
Susana Santo and Diogo Ayres-De-Campos

18 Evaluation of Fetal Pulmonary Maturity 317
Evaldo Trajano de Souza Silva Filho, Matheus Cabral L. Beleza,
and Lucas Trigo

19 Fetal Surgery 333
Masami Yamamoto, Yves Ville, Fernando Javier Rojas Bravo,
Viral Mahesh Pandya, Matthew A. Shanahan,
and Michael W. Bebbington

Part IV Clinical Complications in Pregnancy: Diagnosis and Management

20 Anemia in Pregnancy 377
Camila Luiza Meira Pucci and Lisandra Stein Bernardes

21 Chronic Hypertension in Pregnancy 393
Henri Augusto Korkes, Renato José Bauer, and Nelson Sass

22 Pregestational Diabetes Mellitus 405
Lenita Zajdenverg and Carlos Antonio Negrato

23 Acquired Thrombophilia in Pregnancy 427
André Luiz Malavasi and Daniela Aires Moreira

24 Hereditary Thrombophilia 437
Guilherme Ramires de Jesús, Flavia Cunha dos Santos, Marcela Ignacchiti Lacerda, Roger Abramino Levy, and Nilson Ramires de Jesús

25 Gastrointestinal Disorders 449
Mario Julio Franco and Janaína Luz Narciso-Schiavon

26 Heart Disease during Pregnancy 461
D. P. Esteves and Juliana Silva Esteves

27 Thyroid Disorders 469
Luciana C. Cima, Mariane T. Tauile, Viviane P. Monteiro, and Isabela Bussade

28 Rheumatological Diseases 483
Nilson Ramires de Jesús, Marcela Ignacchiti Lacerda, Flavia Cunha dos Santos, Roger Abramino Levy, and Guilherme Ramires de Jesús

29 Prophylaxis for Deep Venous Thrombosis During Pregnancy, Delivery, and Postpartum 513
Egle Couto and Renato Passini Junior

30 Metabolomics Application in Fetal Medicine 537
G. Monni, F. Murgia, V. Corda, A. Iuculano, and L. Atzori

Part V Pregnancy Complications: Prevention, Diagnosis and Management

31 Prematurity: Relevant Aspects in Asymptomatic Patients 551
Rone Peterson Cerqueira Oliveira

32 Prematurity: Relevant Aspects in the Symptomatic Patient 573
Renato Augusto Moreira de Sá and Eduardo Borges da Fonseca

33 Prematurity: Evaluation of Fetal Well-Being and Delivery 593
Ana B. Bianchi and Miguel Ruoti

34 Antenatal Corticosteroid 627
Viviane P. Monteiro, Luciana C. Cima, and Mariane T. Tauile

35 Magnesium Sulfate in Prevention of Cerebral Palsy 631
Ingrid Schwach Werneck Britto and Mario Henrique Burlacchini de Carvalho

36 Premature Rupture of Membranes 635
Juliana Silva Esteves

37 Fetal Growth Restriction 647
Eva Meler, Leticia Benítez, Judith Martínez, and Francesc Figueras

38 Perinatal Hemolytic Disease 669
Mário Dias Corrêa Júnior, Gabriel Martins Cruz Campos, and Priscila Chaves Pita

39 Disorders of Amniotic Fluid Volume: Oligoamnios and Polyhydramnios 687
Mario S. F. Palermo, Ana Espinosa, and Mónica Trasmonte

40 Preeclampsia 707
Liliana Susana Voto and Moises Gabriel Zeitune

41 Gestational Diabetes 747
Renato Augusto Moreira de Sá and Eduardo Borges da Fonseca

42 Complications of Monochorionic Twin Pregnancy: Double Trouble? 763
Alexandra Matias and Miguel Pereira-Macedo

Part VI Infectious Diseases

43 Urinary Tract Infections 795
Carlos Augusto Faria and José Carlos Carraro-Eduardo

44 Congenital Infection 1 (Syphilis, AIDS, and Viral Hepatitis) 811
Mauro Romero Leal Passos, José Eleutério Junior, Regis Kreitchmann, and Angelica Espinosa Miranda

45 Congenital Infection 2 (Toxoplasmosis, CMV, Rubella) 827
Juliana Silva Esteves, Daniela Aires Moreira, and Eduardo Borges da Fonseca

46 Group B Streptococcus and Pregnancy 845
Renato Augusto Moreira de Sá, Antônio Rodrigues Braga Neto, and Bartolomeu Expedito da Câmara França

47 Arboviruses and Pregnancy (Zika, Dengue, Chikungunya, and Yellow Fever) 857
Penélope Saldanha Marinho, Antonio José Cunha, Joffre Amim Junior, and Arnaldo Prata Barbosa

Part VII Childbirth and Postpartum

48 Cervical Ripening and Labor Induction 875
Renato Augusto Moreira de Sá and Cristiane Alves de Oliveira

49 Analgesia and Anesthesia at Birth 891
Gisele Passos da Costa Gribel

50 Cesarean Delivery 913
Roberto Magliano de Morais Filho and Roberto Magliano de Morais

51 Perinatal Asphyxia (Acute Fetal Distress) 939
Fernanda Campos da Silva, Renato Augusto Moreira de Sá, and Cristiane Alves de Oliveira

52 Maternal Complications in the Immediate Postpartum Period 963
Roxana Knobel, Carla Betina Andreucci, Leila Katz, and Melania M. Amorim

53 Care of the Newborn Infant during the Third Stage of Labor 987
J. L. Diaz-Rossello and M. F. Blasina

Part VIII Neonatal Period

54 Breastfeeding 1015
Cristiane Alves de Oliveira

55 Caring for the Normal Newborn 1041
Milan Stanojevic

56 Palliative Care in Perinatology 1111
Jussara de Lima e Souza

57 Hypoxic-Ischemic Encephalopathy 1123
Maria Elisabeth Lopes Moreira

58 Neonatal Complications of Prematurity 1133
Helenilce de Paula Fiod Costa and Elaine de Paula Fiod Costa

59 Small for Gestational Age 1151
Maria Elisabeth Lopes Moreira and Maria Dalva Barbosa Baker Méio

60 Respiratory Distress Syndrome in the Newborn 1159
José Roberto de Moraes Ramos and Carlos A. Bhering

61 Transient Tachypnea of the Newborn 1169
Carlos A. Bhering and José Roberto de Moraes Ramos

62 Bronchopulmonary Dysplasia 1175
José Maria de Andrade Lopes and Danielle Negri de Souza Lopes

63 Retinopathy of Prematurity 1189
Luiza M. Neves and Andrea Zin

64 Necrotizing Enterocolitis 1215
Renata Bastos Lopes, Maria Elisabeth Lopes Moreira, and Fernanda Hermeto

65 Persistent Pulmonary Hypertension of the Newborn 1229
Fernando de Freitas Martins

66 Intracranial Hemorrhage 1253
Danielle Negri de Souza Lopes, João Henrique Carvalho Leme de Almeida, and Márcia Cristina de Azevedo Gomes

67 Resuscitation of the Newborn Development of Algorithms, Present Status and Future Perspectives 1269
Shamik Trivedi, Siw Helen Westby Eger, and Ola Didrik Saugstad

Index 1289

Contributors

Daniela Aires Moreira University of Medical Sciences, João Pessoa, Paraíba, Brazil

Maternal Fetal Medicine Group, Nova Diagnóstico por Imagem, João Pessoa, Brazil

Melania M. Amorim Post-Graduate Program in Instituto de Medicina Integral Professor Fernando Figueira, Recife, Brazil

Obstetrics & Gynecology, Federal University of Campina Grande, Campina Grande, Brazil

Ana Espinosa Institution Matersur, Teaching and Research, Bahía Blanca, Buenos Aires, Argentina

Carla Betina Andreucci Department of Medicine, Center of Biological and Health Sciences, Federal University of São Carlos, São Carlos, Brazil

L. Atzori Clinical Metabolomics Unit, Department of Biomedical Sciences, University of Cagliari, Cagliari, Italy

Diogo Ayres-De-Campos Departamento de Obstetrícia, Ginecologia e Medicina da Reprodução, Faculdade de Medicina da Universidade de Lisboa, Centro Hospitalar Universitário Lisboa Norte – Hospital de Santa Maria, Lisbon, Portugal

Arnaldo Prata Barbosa Instituto D'Or de Pesquisa e Ensino – IDOR, Rio de Janeiro, Brazil

Lara Spalldi Barišić Fetal and Maternal Medicine, Private Clinic Veritas, Zagreb, Croatia

Renato José Bauer Department of Obstetrics, Faculty of Medicine of Pontifical University of Sao Paulo, City of Sorocaba, SP, Brazil

Michael W. Bebbington Washington University School of Medicine in St. Louis, Louis, US

Matheus Cabral L. Beleza Maternal-Fetal Medicine Department, NEXUS Institute, Brasília, Federal District, Brazil

Augusto César Garcia Saab Benedeti FATESA – Faculdade de Tecnologia em Saúde, Ribeirão Preto, SP, Brazil

Leticia Benítez BCNatal - Barcelona Center for Maternal-Fetal and Neonatal Medicine (Hospital Clínic and Hospital Sant Joan de Deu), University of Barcelona, Barcelona, Spain

Lisandra Stein Bernardes Department of Obstetrics and Gynecology, University of São Paulo, São Paulo, Brazil

Sepaco Hospital, São Paulo, Brazil

School of Medicine, Faculdade Israelita de Ciências da Saúde Albert Einstein, São Paulo, Brazil

Carlos A. Bhering Departamento de Neonatologia do Instituto Fernandes Figueira/ FIOCRUZ, Rio de Janeiro, Brazil

Pediatria da Universidade de Vassouras, Vassouras, Brazil

Ana B. Bianchi Perinatal Department, Pereira Rossell Hospital, Montevideo, Montevideo, Uruguay

M. F. Blasina Department of Neonatology, Hospital de Clínicas, Facultad de Medicina, Universidad de la República, Montevideo, Uruguay

Fernando Javier Rojas Bravo Clínica Universidad de los Andes, Las Condes, Chile

Ingrid Schwach Werneck Britto Department of Obstetrics and Gynecology, Faculty of Medical Sciences of Santa Casa of São Paulo, São Paulo, São Paulo, Brazil

Isabela Bussade Pontifícia Universidade Católica (PUC), Rio de Janeiro, RJ, Brazil

Gabriel Martins Cruz Campos Fetal Medicine Residence – Hospital das Clínicas da UFMG, Belo Horizonte, Brazil

José Carlos Carraro-Eduardo Department of Internal Medicine, School of Medicine, Universidade Federal Fluminense (UFF), Niterói, Rio de Janeiro, Brazil

Ricardo Carvalho Cavalli Department of Obstetrics and Gynecology, Ribeirão Preto Medical School, University of São Paulo, São Paulo, SP, Brazil

Department of Obstetrics and Gynecology, Hospital das Clínicas, Faculty of Medicine, University of São Paulo, FMUSP, São Paulo, SP, Brazil

Frank A. Chervenak Department of Obstetrics and Gynecology, Zucker School of Medicine of Hofstra/Northwell, Lenox Hill Hospital, New York, NY, USA

Luciana C. Cima Perinatal/Rede D'or, Rio de Janeiro, RJ, Brazil

V. Corda Department of Prenatal and Preimplantation Genetic Diagnosis and Fetal Therapy, Ospedale Pediatrico Microcitemico "A. Cao", Cagliari, Italy

Egle Couto Department of Obstetrics and Gynecology, University of Campinas (UNICAMP), Campinas, SP, Brazil

Pontifical Catholic University of Campinas, Campinas, Brazil

Antonio José Cunha Faculdade de Medicina da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Bartolomeu Expedito da Câmara França Materno-Infantil, Federal Fluminense University, Niteroi, RJ, Brazil

Gisele Passos da Costa Gribel Department of Anesthesiology, Hospital Maternidade Escola, Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brazil

Eduardo Borges da Fonseca Maternal Fetal Medicine Group - Nova Diagnóstico por Imagem, João Pessoa, PB, Brazil

Ob/Gyn Department, Federal University of Paraiba, João Pessoa, PB, Brazil

Antonio Claudio Lucas da Nóbrega Laboratório de Ciências do Exercício, Instituto Biomédico, Universidade Federal Fluminense, Niterói, RJ, Brazil

Jair Roberto da Silva Braga Maternidade Escola da UFRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Fabrício da Silva Costa Department of Obstetrics and Gynecology, Ribeirão Preto Medical School – University of São Paulo, Ribeirão Preto, São Paulo, Brazil

Fernanda Campos da Silva Department of Obstetrics, Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro, RJ, Brazil

Marcos José Burle de Aguiar Medicine School, Federal University of Minas Gerais, Belo Horizonte, Brazil

Regina Amélia Lopes Pessoa de Aguiar Medicine School, Federal University of Minas Gerais, Belo Horizonte, Brazil

João Henrique Carvalho Leme de Almeida Neonatology Department, Instituto Nacional da Saúde da Mulher, da Criança e do Adolescente Fernandes Figueira, Fundação Oswaldo Cruz, Rio de Janeiro, RJ, Brazil

José Maria de Andrade Lopes Perinatal Maternity Hospital, Rio de Janeiro, Brazil

Eduardo Carvalho de Arruda Veiga Department of Obstetrics and Gynecology, Ribeirão Preto Medical School, University of São Paulo, São Paulo, SP, Brazil

Márcia Cristina de Azevedo Gomes Clínica Perinatal, Neonatal Intensive Care, Rio de Janeiro, RJ, Brazil

Mario Henrique Burlacchini de Carvalho Department of Obstetrics and Gynecology, Faculty of Medical Sciences of Santa Casa of São Paulo, São Paulo, São Paulo, Brazil

Paulo Roberto Nassar de Carvalho Instituto Fernandes Figueira, Rio de Janeiro, Fundação Oswaldo Cruz –FIOCRUZ, Rio de Janeiro, Brazil

IETECS – Instituto de Estudos de Tecnologia em Saúde, Rio de Janeiro, Brazil

Grupo Perinatal, Rio de Janeiro, Brazil

Victor Rocha de Castro Alves FATESA – Faculdade de Tecnologia em Saúde, Ribeirão Preto, SP, Brazil

Renata Rodrigues Teixeira de Castro Department of Cardiology, Hospital Naval Marcílio Dias & School of Medicine, Iguaçu University, Rio de Janeiro, RJ, Brazil

Fernando de Freitas Martins Neonatology Department, Fernandes Figueira Institute, Oswaldo Cruz Foundation, Neonatal Intensive Care Unit, Perinatal Clinic, Rio de Janeiro, RJ, Brazil

Guilherme Ramires de Jesús Department of Obstetrics, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Nilson Ramires de Jesús Department of Obstetrics, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

José Roberto de Moraes Ramos Departamento de Neonatologia do Instituto Fernandes Figueira/FIOCRUZ, Rio de Janeiro, Brazil

Programa de Reanimação Neonatal da Sociedade Brasileira de Pediatria, Rio de Janeiro, Brazil

Roberto Magliano de Morais Filho Faculdade de Medicina Nova Esperança, Joao Pessoa, Paraiba, Brazil

Roberto Magliano de Morais Universidade Federal da Paraiba, Joao Pessoa, Paraiba, Brazil

Cristiane Alves de Oliveira Federal Fluminense University and Rio de Janeiro Federal University, Niteroi and Rio de Janeiro, Brazil

Elaine de Paula Fiod Costa Medicine Department, Federal University of Maranhão, Maranhão, Brazil

Helenilce de Paula Fiod Costa Neonatology Department, Institution Santa Joana/ Promatre Hospital Group, São Paulo, Brazil

Jorge de Rezende-Filho Maternidade Escola da UFRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Renato Augusto Moreira de Sá Fernandes Figueira Institut - FIOCRUZ, Rio de Janeiro, RJ, Brazil

Danielle Negri de Souza Lopes Neonatology Department, Perinatal Maternity Hospital, Rio de Janeiro, RJ, Brazil

Evaldo Trajano de Souza Silva Filho Maternal-Fetal Medicine Department, NEXUS Institute, Brasília, Federal District, Brazil

J. L. Diaz-Rossello Department of Neonatology, Hospital de Clínicas, Facultad de Medicina, Universidad de la República, Montevideo, Uruguay

Flavia Cunha dos Santos Department of Obstetrics, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Karina dos Santos Research Group on Maternal and Child Health (Grupo de Pesquisa em Saúde Materna e Infantil – GPSMI), Nutrition Institute, Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Joachim Dudenhausen Department of Obstetrics and Gynecology, Zucker School of Medicine at Hofstra/Northwell, New York, NY, USA

Siw Helen Westby Eger Department of Pediatrics and Adolescence Medicine, Oslo University Hospital, Oslo, Norway

D. P. Esteves Department of Cardiology, Pregnancy Heart Disease Sector, Hospital Federal dos Servidores do Estado, Rio de Janeiro, RJ, Brazil

Juliana Silva Esteves Hospital Federal dos Servidores do Estado - Ministry of Health, Rio de Janeiro, RJ, Brazil

Carlos Augusto Faria Department of Maternal and Child Health, School of Medicine, Universidade Federal Fluminense (UFF), Niterói, RJ, Brazil

Francesc Figueras BCNatal - Barcelona Center for Maternal-Fetal and Neonatal Medicine (Hospital Clínic and Hospital Sant Joan de Deu), University of Barcelona, Barcelona, Spain

Francisco Mauad Filho FATESA – Faculdade de Tecnologia em Saúde, Ribeirão Preto, SP, Brazil

Mario Julio Franco Florianópolis, SC, Brazil

Amos Grunebaum Department of Obstetrics and Gynecology, Zucker School of Medicine at Hofstra/Northwell, New York, NY, USA

Fernanda Hermeto Neonatology Department, Perinatal Maternity Hospital, Rio de Janeiro, RJ, Brazil

A. Iuculano Department of Prenatal and Preimplantation Genetic Diagnosis and Fetal Therapy, Ospedale Pediatrico Microcitemico “A. Cao”, Cagliari, Italy

Edward Araujo Júnior Discipline of Fetal Medicine, Department of Obstetrics, Paulista School of Medicine –Federal University of São Paulo (EPM-UNIFESP), São Paulo, SP, Brazil

Joffre Amim Junior Maternidade Escola da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

José Eleutério Junior Department of Women's, Child and Teenager Health, Federal University of Ceará, Fortaleza, Brazil

Mário Dias Corrêa Júnior Obstetrics and Gynecology Department – Faculdade de Medicina da UFMG, Belo Horizonte, Brazil

Renato Passini Junior Department of Obstetrics and Gynecology, University of Campinas (UNICAMP), Campinas, SP, Brazil

Leila Katz Catholic University of Pernambuco (UNICAP), Recife, Brazil

Post-Graduate Program in Instituto de Medicina Integral Professor Fernando Figueira, Recife, Brazil

Roxana Knobel Faculty of Medical Sciences, State University of Campinas – UNICAMP, Campinas, Brazil

Department of Obstetrics & Gynecology, Federal University of Santa Catarina (UFSC), Florianópolis, Brazil

Henri Augusto Korkes Department of Obstetrics, Faculty of Medicine of Pontifical University of Sao Paulo, City of Sorocaba, SP, Brazil

Regis Kreitchmann Department of Gynecology and Obstetrics, Federal University of Health Sciences of Porto Alegre, Porto Alegre, Brazil

Asim Kurjak Sarajevo School of Science and Technology, Sarajevo, Bosnia and Herzegovina

Department of Obstetrics and Gynecology, School of Medicine, University of Zagreb, Zagreb, Croatia

Marcela Ignacchiti Lacerda Department of Obstetrics, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Roger Abramino Levy Immunology and Inflammation, GlaxoSmithKline (GSK), Upper Providence, PA, USA

Renata Bastos Lopes Neonatology Department, Perinatal Maternity Hospital, Rio de Janeiro, RJ, Brazil

Jürgen Lüthje Institute of Perinatal Medicine, Berlin-Neukölln, Germany

André Luiz Malavasi Pérola Byington Hospital, São Paulo, Brazil

Hospital do Servidor Público Municipal de São Paulo, São Paulo, Brazil

International Society on Thrombosis and Haemostasis, São Paulo, Brazil

Penélope Saldanha Marinho Maternidade Escola da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Judith Martínez BCNatal - Barcelona Center for Maternal-Fetal and Neonatal Medicine (Hospital Clínic and Hospital Sant Joan de Deu), University of Barcelona, Barcelona, Spain

Alexandra Matias Department of Obstetrics, Gynecology and Pediatrics, Faculty of Medicine University of Porto, Centro Hospitalar Universitário Hospital of S. João, Porto, Portugal

Laurence B. McCullough Department of Obstetrics and Gynecology, Zucker School of Medicine of Hofstra/Northwell, Lenox Hill Hospital, New York, NY, USA

Maria Dalva Barbosa Baker Méio Instituto Fernandes Figueira- Fiocruz, Rio de Janeiro, Brazil

Eva Meler BCNatal - Barcelona Center for Maternal-Fetal and Neonatal Medicine (Hospital Clínic and Hospital Sant Joan de Deu), University of Barcelona, Barcelona, Spain

Angelica Espinosa Miranda Department of Social Medicine, Federal Universty of Espírito Santo, Vitória, Brazil

Carolina Carvalho Mocarzel Department of Obstetrics, Hospital Federal dos Servidores do Estado, Rio de Janeiro, Rio de Janeiro, Brazil

G. Monni Department of Prenatal and Preimplantation Genetic Diagnosis and Fetal Therapy, Ospedale Pediatrico Microcitemico "A. Cao", Cagliari, Italy

Viviane P. Monteiro Instituto Fernandes Figueira/Fiocruz, Rio de Janeiro, RJ, Brazil

Maria Elisabeth Lopes Moreira Instituto Fernandes Figueira - Fiocruz, Clinica Perinatal Laranjeiras, Rio de Janeiro, RJ, Brazil

F. Murgia Clinical Metabolomics Unit, Department of Biomedical Sciences, University of Cagliari, Cagliari, Italy

Janaína Luz Narciso-Schiavon Florianópolis, SC, Brazil

Carlos Antonio Negrato Medical school from Faculdade de Odontologia de Bauru (FOB), Universidade de São Paulo, Bauru, São Paulo, Brazil

Antônio Rodrigues Braga Neto Materno-Infantil, Federal Fluminense University, Niteroi, RJ, Brazil

Luiza M. Neves Instituto NAcional de Saude da Mulher, da Criança e do Adolescente, FIOCRUZ, Rio de Janeiro, Brazil

Departamento de Oftalmologia, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Ana Carla Zanchietta Nicolielo Maternidade Perinatal, Department of Obstetrícia, Rio de Janeiro, Rio de Janeiro, Brazil

Rone Peterson Cerqueira Oliveira Department of Gynecology, Obstetrics and Human Reproduction, Federal University of Bahia, Salvador, Bahia, Brazil

Mario S. F. Palermo Diagnomed Affiliated Institution Faculty of Medicine of Buenos Aires, Teaching and Research, Buenos Aires, Argentina

Viral Mahesh Pandya GHU Paris-Centre, Hôpital Necker-Enfants Malades, Paris, France

Mauro Romero Leal Passos Department of Microbiology and Parasitology, Fluminense Federal University, Niterói, Brazil

Alberto Borges Peixoto Department of Gynecology and Obstetrics, University of Uberaba (UNIUBE), Uberaba, Brazil

Department of Gynecology and Obstetrics, Federal University of Triângulo Mineiro (UFTM), Uberaba, Brazil

Fernando Barbosa Peixoto Department of Obstetrics and Gynecology, Ribeirão Preto Medical School, University of São Paulo, São Paulo, SP, Brazil

Fernando Maia Peixoto-Filho Instituto Fernandes Figueira, Rio de Janeiro, Fundação Oswaldo Cruz –FIOCRUZ, Rio de Janeiro, Brazil

IETECS – Instituto de Estudos de Tecnologia em Saúde, Rio de Janeiro, Brazil

Grupo Perinatal, Rio de Janeiro, Brazil

Miguel Pereira-Macedo Centro Hospitalar Universitário Lisboa Central, Lisbon, Portugal

Rafaela Cardoso Gil Pimentel FATESA – Faculdade de Tecnologia em Saúde, Ribeirão Preto, SP, Brazil

Priscila Chaves Pita Ultrasonography Residence – Hospital das Clínicas da UFMG, Belo Horizonte, Brazil

Cristos Pritsivelis Maternidade Escola da UFRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Camila Luiza Meira Pucci Department of Obstetrics and Gynecology, University of São Paulo, São Paulo, Brazil

Sepaco Hospital, São Paulo, Brazil

Conrado Sávio Ragazini Department of Obstetrics and Gynecology, Ribeirão Preto Medical School – University of São Paulo, Ribeirão Preto, São Paulo, Brazil

Gustavo Mourão Rodrigues Department of Obstetrics, Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Rio de Janeiro, Rio de Janeiro, Brazil

Miguel Ruoti University Asuncion, Asunción, Paraguay

Erich Saling Institute of Perinatal Medicine, Berlin-Neukölln, Germany

Susana Santo Departamento de Obstetrícia, Ginecologia e Medicina da Reprodução, Faculdade de Medicina da Universidade de Lisboa, Centro Hospitalar Universitário Lisboa Norte – Hospital de Santa Maria, Lisbon, Portugal

Nelson Sass Department of Obstetrics, Universidade Federal de São Paulo (Federal University of São Paulo) – UNIFESP, City of Sao Paulo, SP, Brazil

Ola Didrik Saugstad Ann & Robert H. Lurie Children's Hospital of Chicago and Prentice Women's Hospital, Division of Neonatology, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

Department of Pediatric Research, Oslo University Hospital and University of Oslo, Oslo, Norway

Cláudia Saunders Research Group on Maternal and Child Health (Grupo de Pesquisa em Saúde Materna e Infantil – GPSMI), Nutrition Institute, Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Matthew A. Shanahan Washington University School of Medicine in St. Louis, Louis, US

Jussara de Lima e Souza Neonatology and Palliative Medicine, University of Campinas – UNICAMP, Clinic of Neonatology, Women's Hospital – CAISM, University of Campinas (UNICAMP), Campinas, Brazil

Milan Stanojevic Clinical Hospital Sveti Duh, Department of Obstetrics and Gynecology Medical School University of Zagreb, Neonatal Unit, Zagreb, Croatia

Mariane T. Tauile Perinatal/Rede D'or, Rio de Janeiro, RJ, Brazil

Julio Cesar Teixeira Department of Gynecology and Obstetrics, Faculty of Medical Sciences, University of Campinas (UNICAMP), Campinas, SP, Brazil

Mónica Trasmonte Hospital Nacional Prof. Dr. A. Posadas, MATERNAL CHILD, Buenos Aires, Argentina

Lucas Trigo Maternal-Fetal Medicine Department, Fetal Medicine Research Center (BCNatal), Hospital Clinic and Hospital Sant Joan de Déu, University of Barcelona, Barcelona, Catalunya, Spain

Shamik Trivedi Ann & Robert H. Lurie Children's Hospital of Chicago and Prentice Women's Hospital, Division of Neonatology, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

Yves Ville GHU Paris-Centre, Hôpital Necker-Enfants Malades, Paris, France

Liliana Susana Voto Maternal and Childbirth Department, Hospital General de Agudos Dr. Juan A. Fernandez, School of Medicine, University of Buenos Aires, Buenos Aires, Argentina

Masami Yamamoto GHU Paris-Centre, Hôpital Necker-Enfants Malades, Paris, France

Lenita Zajdenverg Internal Medicine Department, Diabetes Division, Hospital Universitário Clementino Fraga Filho, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

Moises Gabriel Zeitune Maternal and Childbirth Department, Hospital General de Agudos Dr. Juan A. Fernández, School of Medicine, University of Buenos Aires, Buenos Aires, Argentina

Andrea Zin Instituto NAcional de Saude da Mulher, da Criança e do Adolescente, FIOCRUZ, Rio de Janeiro, Brazil

Part I
Periconceptional Care

Chapter 1
Historical Preface: Early Stages of Perinatal Medicine

Erich Saling and Jürgen Lüthje

Obstetrical medicine and obstetrical science have a long history. Far in the past, the Greek gynecologist Soranos of Ephesos (98–138) wrote a textbook which was essential for centuries: "De arte obstetrica morbisque mulierum" [1]. However, since its beginning, obstetrics had been predominantly mother-oriented for a very long time until the middle of the twentieth century.

Although first attempts have been made in earlier decades to assess some signs of existence of the fetus (e.g., with auscultation of its heart rate, see below), very little was known about clinically useful parameters of the fetal condition.

The Fetus as a New Patient in Obstetrics

The most impressive evolutionary event in obstetrics was the great change from predominantly mother-oriented obstetrics with its considerable operative character, to a combined also embryo- and fetus-oriented widespread concept. This began in the 1960s, when for the first time also the unborn became accessible to applied routine medicine. In 1966, the two British pediatricians Dobbs and Gairdner wrote: "With the advent of the techniques of amnioscopy and foetal blood sampling developed by Saling, and of amniocentesis and foetal transfusion due to Bevis and to Liley, we witness the end of the long period of foetal inaccessibility and, we hopefully believe, the start of the science of foetal medicine" [2].

The development—particularly of the prenatal part of Perinatal Medicine—was explosive. In the meantime, it has achieved an enormous extent and has become widespread. It was started by obstetricians, and in the following years,

E. Saling (✉) · J. Lüthje
Institute of Perinatal Medicine, Berlin-Neukölln, Germany
e-mail: prof@saling-institut.de; http://www.saling-institut.de

R. A. Moreira de Sá, E. B. d. Fonseca (eds.), *Perinatology*,
https://doi.org/10.1007/978-3-030-83434-0_1

they came close together with open-minded pediatricians and colleagues from other interested disciplines. They created powerful interdisciplinary cooperation. In this context, in 1967, we coined the term "Perinatal Medicine" [3]. In this young medical subdiscipline, new methods for routine diagnosis and therapy were introduced, and its rapid development would not have been possible without new structures in clinical care as well as in scientific organization, research, and education.

Development of New Methods

Up to the end of the 1960s, in applied routine medicine the following main subfields had developed:

- Assessment of fetal heart activity
- Fetal blood analysis
- Examination of amniotic fluid
- Application of ultrasonography
- Neonatological assessment

Assessment of Fetal Heart Activity

Already in 1818, during a lecture, Mayor remarked on the existence of fetal heart sounds for the first time [4], and in 1821 Kergaradec reported in more detail on simple auscultation of fetal heart sounds [5]. In 1833, Kennedy from Dublin published a monumental monograph on the observations of obstetric auscultation of the fetal heart [6]. According to Goodlin, many of Kennedy's clinical impressions concerning various fetal heart rate patterns are compatible with current concepts. Kennedy included, for example, Bodson's statement that the most ominous fetal heart rate pattern was "slowness of its return when a contraction is passing on" [7]. The first measurement of intrauterine pressure during labor was done in Germany in 1872 by Schatz, using a transcervically inserted balloon [8].

Fetal cardiography, this means recording the fetal heartbeats, started in 1890 when Pestalozza recorded heartbeats by a sphygmograph for the first time [9]. Cremer was successful in recording the first fetal electrocardiogram in 1906 [10], in which the small fetal signals could be differentiated from the bigger ones of the mother. In 1908, Hofbauer and Weiss recorded the first phono-cardiogram [11]. Beruti from Buenos Aires developed a phonocardiograph that could be applied in clinical practice. He combined the microphone with a telephone and predicted already in 1927, that in the future, obstetricians would be able to monitor the pregnant patient from the distance [12].

The two outstanding pioneers of modern electronically based fetal heart rate surveillance are Edward Hon and Roberto Caldeyro-Barcia. In 1957, Hon succeeded in separating the fetal signals out of the abdominally recorded maternal and fetal complexes and thus laid the basis for modern cardiography [13, 14]. Roberto Caldeyro-Barcia was not only a main pioneer of cardiotocography but also of uterine physiology and pathophysiology. In 1958, Caldeyro-Barcia and his coworkers were the first who recorded the fetal heart rate in combination with uterine contractions [15, 16]. This was the initial step for modern heart rate monitoring. All these registrations required the usage of complicated huge equipment and could therefore only serve experimental purposes. They were hardly suitable for widespread routine clinical use.

The breakthrough leading to later practical clinical usage came in the 1960s when Hammacher in cooperation with Hewlett Packard was successful in developing suitable transportable equipment, called cardiotocograph (Fig. 1.1), which was based on the phonocardiographic principle [17]. Equipment for widespread use was not available until 1968. But from then on cardiotocography developed rapidly into a surveillance method used all over the world.

Other pioneers in cardiotocography, particularly in the use of Doppler CTG, were Kazuo Maeda from Japan [18] and Mosler from Germany [19].

When we met Caldeyro-Barcia in October 1964 in Montevideo, we performed the first combined examinations of three fetuses. That is, when pathological heart rate patterns were present, we examined the fetal acid–base situation with our fetal blood analysis, which had been developed 4 years earlier.

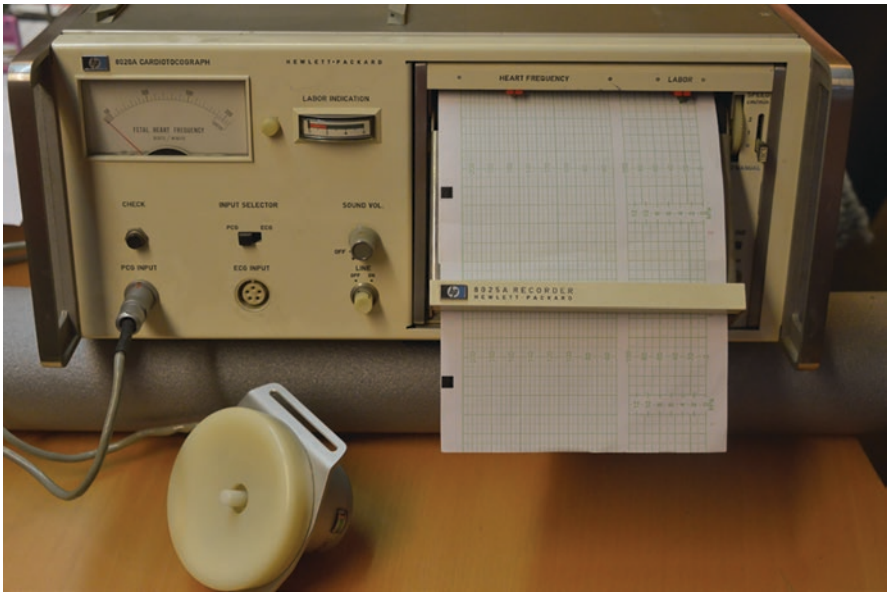

Fig. 1.1 Early model (8020A) of a transportable cardiotocograph developed by Hammacher in cooperation with Hewlett Packard, suitable for clinical use. (© Erich Saling)

Later, in 1968, when cardiotocography became available for routine use, in our department the very first real study of combined assessment of the fetus by cardiotocography and fetal blood analysis was conducted in 146 cases. In 1970, we presented the results from 489 cases at the second European Congress of Perinatal Medicine in London. We were surprised that in a number of cases, even with bradycardia, there were normal pH values. In 52 cases with bradycardia with less than 120 bpm, there were acidotic pH values only in 33% [20]. Many later studies have confirmed this weakness of cardiotocography, i.e., often yielding false-positive results.

Later considerable progress has been achieved particularly by the introduction of computer assessment of cardiotocograms. Pioneers in this field have been Geoffrey Dawes and his coworkers Visser and Redman, who already in 1978 started to evaluate different patterns of cardiotocograms by the use of computers, published in 1981 [21].

Fetal Blood Analysis

Eight years before, cardiotocography became available for widespread routine application, the first direct approach to the human fetus that could be used for routine clinical practice had been achieved. This can be considered as the moment of the birth of intrauterine medicine. It was in Berlin on June 21, 1960 (first published in 1961 [22, 23]) when we started sampling and examining the fetal blood from its presenting part (Fig. 1.2). First, there were serological and hematological examinations, followed by blood gas and acid–base analysis. Consequently, the fetus for the first time became a real patient apart from the mother, and obstetrics underwent an essentially new character.

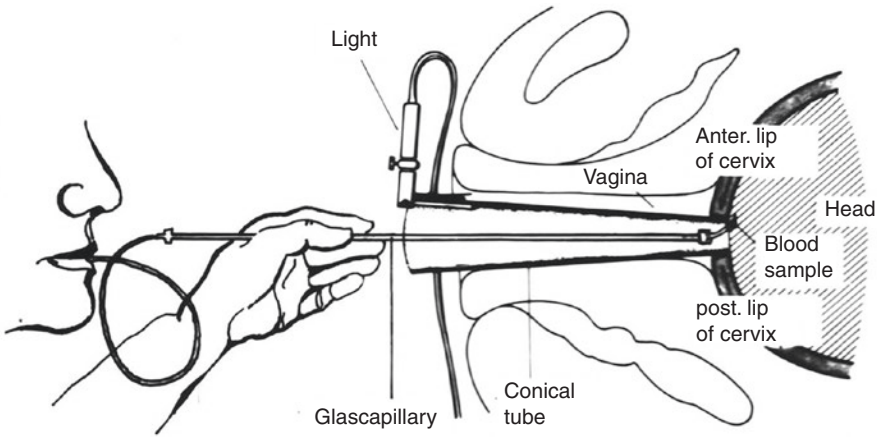

Fig. 1.2 Fetal blood analysis. (© Erich Saling)