

FOURTH EDITION

Practical Transfusion Medicine

Edited by

Michael F. Murphy, Derwood H. Pamphilon
and Nancy M. Heddle



 WILEY-BLACKWELL

Practical Transfusion Medicine

EDITED BY

Michael F. Murphy MD, FRCP, FrcPath

Professor of Blood Transfusion Medicine

University of Oxford;

Consultant Haematologist

NHS Blood and Transplant and Department of Haematology

John Radcliffe Hospital

Oxford, UK

Derwood H. Pamphilon MD, MRCPCH, FRCP, FrcPath

Formerly, Consultant Haematologist

NHS Blood and Transplant

Bristol, UK;

Honorary Clinical Reader

Department of Cellular and Molecular Medicine

University of Bristol

Bristol, UK

Nancy M. Heddle MSc, FCSMLS(D)

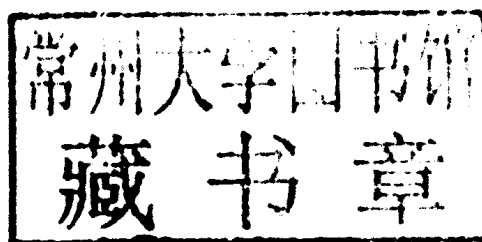
Director, MTRP

Professor, Department of Medicine

McMaster University

Canadian Blood Services

Hamilton, ON, Canada



FOURTH EDITION

 **WILEY-BLACKWELL**

A John Wiley & Sons, Ltd., Publication

This edition first published 2013 © 2001, 2005, 2009, 2013 by John Wiley & Sons Ltd.

Wiley-Blackwell is an imprint of John Wiley & Sons, formed by the merger of Wiley's global Scientific, Technical and Medical business with Blackwell Publishing.

Registered office: John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial offices: 9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
111 River Street, Hoboken, NJ 07030-5774, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell

The right of the author to be identified as the author of this work has been asserted in accordance with the UK Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

The contents of this work are intended to further general scientific research, understanding, and discussion only and are not intended and should not be relied upon as recommending or promoting a specific method, diagnosis, or treatment by physicians for any particular patient. The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of fitness for a particular purpose. In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of medicines, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each medicine, equipment, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. Readers should consult with a specialist where appropriate. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read. No warranty may be created or extended by any promotional statements for this work. Neither the publisher nor the author shall be liable for any damages arising herefrom.

Library of Congress Cataloging-in-Publication Data

Practical transfusion medicine / edited by Michael F. Murphy, Derwood H. Pamphilon, Nancy M. Heddle. – 4th ed.

p. ; cm.

Includes bibliographical references and index.

ISBN 978-0-470-67051-4 (hardback : alk. paper)

I. Murphy, Michael F. (Michael Furber) II. Pamphilon, Derwood H. III. Heddle, Nancy M.

[DNLM: 1. Blood Transfusion. 2. Blood Grouping and Crossmatching.

3. Blood Preservation. 4. Cross Infection—prevention & control.

5. Hematopoietic Stem Cell Transplantation. WB 356]

615.3'9—dc23

2012037179

A catalogue record for this book is available from the British Library.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Cover image: Cover image from left to right: © drlwa/iStockphoto; withgod/iStockphoto; luchshen/iStockphoto; Michelle Del Guercio/Science Photo Library

Cover design by Steve Thompson

Set in 9/11.5pt Sabon by Aptara® Inc., New Delhi, India

Printed and bound in Singapore by Markono Print Media Pte Ltd

Practical Transfusion Medicine

List of contributors

Jean-Pierre Allain MD, PhD, FrcPath, FMedSc
NHS Blood and Transplant Cambridge;
Division of Transfusion Medicine
Department of Haematology
University of Cambridge
Cambridge, UK

David L. Allen FIBMS
Clinical Scientist
NHS Blood and Transplant;
Research Scientist
University of Oxford
John Radcliffe Hospital
Oxford, UK

Donald M. Arnold MD, MSc
Associate Professor
Department of Medicine
McMaster University;
Canadian Blood Services
Hamilton, ON, Canada

James P. AuBuchon MD, FCAP, FRCP(Edin)
President & CEO
Puget Sound Blood Center and University of
Washington Seattle
Seattle, WA, USA

Imelda Bates FRCP, FrcPath
Senior Clinical Lecturer in Tropical Haematology
Liverpool School of Tropical Medicine
Liverpool, UK

Susan J. Brunskill MSc
Senior Scientist
NHS Blood and Transplant
Systematic Review Initiative
Oxford, UK

Rebecca Cardigan BSc, PhD, FrcPath
Consultant Clinical Scientist
National Head of Components Development
NHS Blood and Transplant
Cambridge, UK

Akila Chandrasekar MB BS, FrcPath
Consultant in Transfusion Medicine
NHS Blood and Transplant Tissue Services
Liverpool, UK

Nicola Curry RA, MA, MB Bchir, MRCP,
FrcPath
Haematology Research Fellow
John Radcliffe Hospital
Oxford, UK

Geoff Daniels PhD, FrcPath
Consultant Clinical Scientist
Bristol Institute for Transfusion Sciences
NHS Blood and Transplant
Bristol, UK

Robertson D. Davenport MD
Associate Professor
Department of Pathology
University of Michigan Health System
Ann Arbor, MI, USA

Dana V. Devine PhD
Vice President, Medical, Scientific & Research Affairs
Canadian Blood Services
Ottawa, ON, Canada;
Professor of Pathology and Laboratory Medicine
Centre for Blood Research
University of British Columbia
Vancouver, BC, Canada

LIST OF CONTRIBUTORS

Roger Y. Dodd PhD

Vice President, Research and Development
American Red Cross
Holland Laboratory for the Biomedical Sciences
Rockville, MD, USA

Carolyn Doree PhD

Information Scientist
NHS Blood and Transplant
Systematic Review Initiative
Oxford, UK

Katharine A. Downes MD

Assistant Professor
University Hospitals Case Medical Center and
Case Western Reserve University
Cleveland, OH, USA

Walter H. Dzik MD

Blood Transfusion Service
Massachusetts General Hospital;
Associate Professor
Harvard Medical School
Boston, MA, USA

Khaled El-Ghariani MA, FRCP, FrcPath

Consultant in Haematology and Transfusion
Medicine
NHS Blood and Transplant and Sheffield Teaching
Hospitals NHS Trust;
Honorary Senior Lecturer
University of Sheffield
Sheffield, UK

Lise J. Estcourt MB BChir, MA, MA(MEL), MRCP, FrcPath

Research Registrar
NHS Blood and Transplant
John Radcliffe Hospital
Oxford, UK

Dean Fergusson MHA, PhD

Senior Scientist
University of Ottawa Center for Transfusion
Research
Clinical Epidemiology Program

The Ottawa Health Research Institute
Ottawa, ON, Canada

Stephen Field FrcPath (SA), MMed, MBChB

Medical Director
Welsh Blood Service
Cardiff, Wales, UK

Peter Flanagan FRCP, FrcPath, FRCPA

National Medical Director
New Zealand Blood Service
Auckland, New Zealand

Ronan Foley MD, FRCPC

Associate Professor of Pathology and Molecular
Medicine
Department of Pathology and Molecular
Medicine
McMaster University
Hamilton, ON, Canada

J. J. Francis PhD

Health Services Research Unit
University of Aberdeen
Aberdeen, Scotland, UK

Richard O. Francis MD, PhD

New York Blood Center
New York, NY;
Department of Pathology and Cell Biology
Columbia University Medical Center
New York, NY, USA

Ian M. Franklin PhD, FRCP, FrcPath

Medical & Scientific Director
Consultant Haematologist
Irish Blood Transfusion Service
National Blood Centre
Dublin, Republic of Ireland

Mark K. Fung MD, PhD

Associate Professor of Pathology and Laboratory
Medicine
University of Vermont;
Fletcher Allen Health Care
Burlington, VT, USA

Mindy Goldman MD

Executive Medical Director
Donor and Transplantation Services
Canadian Blood Services
Ottawa, ON, Canada

Lawrence Tim Goodnough MD

Professor of Pathology and Medicine
Departments of Pathology and Medicine
Stanford University
Stanford, CA, USA

Andreas Greinacher MD

Professor of Transfusion Medicine and Haemostasis
Department of Immunology and Transfusion
Medicine
Universitätsmedizin Greifswald
Greifswald, Germany

Paul C. Hébert MD, FRCPC, MHSc(Epid)

Professor
University of Ottawa Center for Transfusion
Research
Clinical Epidemiology Program
The Ottawa Health Research Institute
Ottawa, ON, Canada

Nancy M. Heddle MSc, FCSMLS(D)

Director, MTRP
Professor, Department of Medicine
McMaster University;
Canadian Blood Services
Hamilton, ON, Canada

John R. Hess MD, MPH, FACP, FAAAS

Departments of Pathology and Medicine
University of Maryland School of Medicine
Baltimore, MD, USA

Patricia E. Hewitt FRCP, FrcPath

Consultant in Transfusion Medicine/Clinical
Transfusion Microbiology
NHS Blood and Transplant
London, UK

Christopher D. Hillyer MD

President & CEO
New York Blood Center
New York, NY, USA;
Professor
Department of Medicine
Weill Cornell Medical College
New York, NY, USA

Sally Hopewell MSc, DPhil

UK Cochrane Centre
Oxford, UK

Rachael Hough BmedSci, BMBS, MD, FRCP,

FrcPath
Consultant Haematologist and Clinical Lead of the
Children and Young People's Cancer Service
University College Hospital's NHS Foundation Trust
London, UK

Beverley J. Hunt MD, FRCP, FrcPath

Professor of Thrombosis and Haemostasis
Kings College, London;
Consultant
Departments of Haematology, Pathology and
Rheumatology
Guy's and St Thomas' NHS Foundation Trust
London, UK

Ram Kakaiya MD

Medical Director
Life Source Blood Services
Rosemont, IL, USA

Louis M. Katz MD

Executive Vice President, Medical Affairs
America's Blood Centers
Washington, DC, USA

Richard M. Kaufman MD

Medical Director, BWH Adult Transfusion Service
Assistant Professor of Pathology, Harvard Medical
School
Blood Bank
Brigham and Women's Hospital
Boston, MA, USA

John Kearney BSc, PhD, CBiol, MIBiol, SRCS
Head of Tissue Services/Lead Scientist/PI for
Research
Tissue Services
NHS Blood and Transplant
Liverpool, UK

Alan D. Kitchen PhD
Head, National Transfusion Microbiology Reference
Laboratory;
NHS Blood and Transplant
Colindale, London, UK

Steven H. Kleinman MD
Clinical Professor of Pathology
University of British Columbia
Victoria, BC, Canada

Mark W. Lowdell BSc, MSc, PhD, FrcPath
Senior Lecturer in Haematology
Royal Free and University College Medical School
Royal Free Hospital
London, UK

Naomi Luban BA, MD
Professor of Paediatrics and Pathology
George Washington University School of Medicine
and Health Sciences
Washington, DC, USA

Geoffrey F. Lucas PhD, FIBMS, DMS
Principal Clinical Scientist
NHS Blood and Transplant
Bristol, UK

Samuel J. Machin MD, FRCP, FrcPath
Professor of Haematology
Haemostasis Research Unit
Department of Haematology
University College London
London, UK

Edwin J. Massey MB ChB, FRCP, FrcPath
Associate Medical Director, Patient Services
NHS Blood and Transplant;
Consultant Haematologist
University Hospitals Bristol NHS Foundation Trust
Bristol, UK

Vickie McDonald MA, PhD, MRCP, FrcPath
Consultant Haematologist
University College London Hospitals NHS
Foundation Trust
London, UK

I. Grant McQuaker DM, MRCP, FrcPath
Consultant Haematologist
BMT Unit
Beatson West of Scotland Cancer Centre
Glasgow, Scotland, UK

Ellen McSweeney MB, MRCP(UK), FrcPath
Consultant Haematologist
Irish Blood Transfusion Service
National Blood Centre
Dublin, Republic of Ireland

Siraj A. Misbah MSc, FRCP, FrcPath
Consultant Clinical Immunologist
Lead for Clinical Immunology
Oxford University Hospitals, University of Oxford
Oxford, UK

Emma Morris MA, PhD, MRCP, MRCPath
Reader in Immunotherapy
Department of Immunology and Molecular
Pathology
Royal Free and University College Medical School
London;
Honorary Consultant Haematologist (BMT)
Department of Haematology
University College London Hospitals
NHS Trust
London, UK

William G. Murphy MD, FRCPEdin, FrcPath
Clinical Lead, Blood Transfusion Programme,
Health Service Executive, Clinical Strategies and
Programmes
Dublin;
Clinical Senior Lecturer
School of Medicine and Medical Science
University College Dublin
Dublin, Republic of Ireland

Gavin J. Murphy MBChB, MD, FRCS
British Heart Foundation Professor of Cardiac
Surgery
School of Cardiovascular Sciences
University of Leicester
Leicester, UK

Michael F. Murphy MD, FRCP, FrcPath
Professor of Blood Transfusion Medicine
University of Oxford;
Consultant Haematologist
NHS Blood and Transplant and Department of
Haematology
John Radcliffe Hospital
Oxford, UK

Cristina V. Navarrete PhD, FrcPath
Consultant Clinical Scientist
Director of Histocompatibility & Immunogenetics
Services
NHS Blood and Transplant
Colindale Centre;
Honorary Reader in Immunology
University College London
London, UK

Paul M. Ness MD
Director, Transfusion Medicine Division
Johns Hopkins Medical Institutions;
Professor, Pathology, Medicine, and Oncology
Johns Hopkins University School of Medicine
Baltimore, MD, USA

Helen V. New PhD, MRCP, FrcPath
Honorary Senior Lecturer
Consultant in Paediatric Haematology and
Transfusion Medicine
Department of Paediatrics
Imperial College Healthcare NHS Trust/NHS Blood
and Transplant
London, UK

Pamela O'Hoski ART
Department of Pathology and Molecular Medicine
McMaster University
Hamilton, ON, Canada

Derwood H. Pamphilon MD, MRCPCH,
FRCP, FrcPath
Formerly, Consultant Haematologist
NHS Blood and Transplant
Bristol;
Honorary Clinical Reader
Department of Cellular and Molecular Medicine
University of Bristol
Bristol, UK

Nishith Patel MBBS, MRCS
Clinical Research Fellow in Cardiac Surgery
School of Clinical Sciences
University of Bristol
Bristol, UK

Chris V. Prowse MA, DPhil, FrcPath
Retired, Professor of Transfusion Science
Edinburgh University,
Edinburgh, Scotland, UK

Sandra Ramírez-Arcos MSc, PhD, ARMCCM
Development Scientist and Adjunct Professor
Canadian Blood Services
Ottawa, ON, Canada

David Rees MA, FRCP, FrcPath
Senior Lecturer and Honorary Consultant in
Paediatric Haematology
Department of Haematological Medicine
NHS Foundation Trust
King's College Hospital
London, UK

Biddy Ridler Mb, ChB, DObst, RCOG, AHEA
Blood Conservation Specialty Doctor
Honorary University Fellow
Peninsula College of Medicine and Dentistry
Royal Devon and Exeter Hospitals
Exeter, UK

David J. Roberts DPhil, MRCP, FrcPath
Professor of Haematology
University of Oxford;
Consultant Haematologist

LIST OF CONTRIBUTORS

NHS Blood and Transplant and Department of
Haematology
John Radcliffe Hospital
Oxford, UK

Irene Roberts MD, FRCP, FrcPath, FRCPCH,
DRCOG
Professor of Paediatric Haematology and Honorary
Consultant Paediatric Haematologist
Departments of Haematology and Paediatrics
Imperial College London
London, UK

Paul Rooney BSc, PhD
Research and Development Manager for Tissue
Services
NHS Blood and Transplant Tissue Services
Liverpool, UK

Marion Scott BSc, PhD
National Research and Development Manager
NHS Blood and Transplant
Bristol, UK

Aryeh Shander MD, FCCM, FCCP
Chief, Department of Anesthesiology, Critical Care
and Hyperbaric Medicine
Englewood Hospital and Medical Center
Englewood, NJ;
Professor of Anesthesiology, Medicine and Surgery
Mount Sinai School of Medicine
New York, NY, USA

Beth H. Shaz MD
Chief Medical Officer
New York Blood Center
New York, NY;
Clinical Associate Professor
Department of Pathology and Laboratory
Medicine
Emory University School of Medicine
Atlanta, GA, USA

Simon J. Stanworth MRCP (Paeds), DPhil,
FrcPath
Consultant Haematologist
University of Oxford;

NHS Blood and Transplant and Department of
Haematology
John Radcliffe Hospital
Oxford, UK

Susan L. Stramer MS, PhD
Executive Scientific Officer
American Red Cross
Scientific Support Office
Gaithersburg, MD, USA

Zbigniew ‘Ziggy’ M. Szczepiorkowski
MD, PhD, FCAP
Section Chief, Clinical Pathology
Medical Director, Transfusion Medicine Service
Director, Cellular Therapy Center
Medical Director, Center for Transfusion Medicine
Research
Dartmouth-Hitchcock Medical Center;
Lebanon, NH;
Associate Professor of Pathology and of
Medicine
Geisel School of Medicine at Dartmouth
Hanover, NH, USA

Richard Tedder BA, MA Cantab, MB BChir
Cantab, FRCP, FrcPath
NHSBT/HPA Epidemiology Unit
NHS Blood and Transplant
Colindale, London, UK

Dafydd Thomas MBChB, FRCA
Consultant in Intensive Care Medicine
Morriston Hospital
Swansea, Wales, UK

Stephen Thomas BSc, PhD
Manager, Component Development Laboratory
NHS Blood and Transplant
Brentwood, UK

John Thompson MS, FRCsed, FRCS
Consultant Surgeon
Peninsula College of Medicine and Dentistry
Royal Devon and Exeter Hospitals
Exeter, UK

Alan T. Tinmouth MD, MSc (Clin Epi), FRCPC
Head, General Hematology and Transfusion
Medicine
Division of Hematology, Department of Medicine,
Ottawa Hospital;
Scientist, University of Ottawa Centre for
Transfusion Research
Clinical Epidemiology Program
The Ottawa Health Research Institute
Ottawa, ON, Canada

Marc L. Turner MB, ChB, MBA, PhD, FRCP,
FrcPath
Professor of Cellular Therapy
Medical Director
Scottish National Blood Transfusion Service
Edinburgh, Scotland, UK

Eleftherios C. Vamvakas MD, PhD, MPH
Rita & Taft Schreiber Chair in Transfusion Medicine
Professor and Vice-Chair, Clinical Pathology
Department of Pathology and Laboratory Medicine
Cedars-Sinai Medical Center
Los Angeles, CA, USA

S. Marieke van Ham PhD
Professor of Biological Immunology
Head, Department of Immunopathology
Sanquin Research and Landsteiner Laboratory
Academic Medical Center, University of Amsterdam
Amsterdam, The Netherlands

Timothy S. Walsh BSc(Hons), MBChB(Hons)
FRCP, FRCA, MD, MRes(PHS)
Professor of Critical Care, Clinical and
Surgical Sciences
Edinburgh University;
Consultant in Anaesthetics and Intensive Care
Edinburgh Royal Infirmary
Edinburgh, Scotland, UK

Theodore E. Warkentin MD, FRCPC, FACP
Professor, Department of Pathology and Molecular
Medicine and Department of Medicine
Michael G. DeGroote School of Medicine,
McMaster University;
Regional Director, Transfusion Medicine
Hamilton Regional Laboratory Medicine Program;
Hematologist, Service of Clinical Hematology
Hamilton Health Sciences
Hamilton, ON, Canada

Kathryn E. Webert MD, MSc, FRCPC
Associate Professor
Department of Medicine and Department of
Molecular Medicine and Pathology
McMaster University;
Canadian Blood Services
Hamilton, ON, Canada

Erica M. Wood MBBS, FRACP, FRCPA
Consultant Haematologist, Monash Medical Centre;
Clinical Associate Professor
Departments of Clinical Haematology and
Epidemiology and Preventive Medicine
Monash University;
Melbourne, VIC, Australia

Mark H. Yazer MD
The Institute for Transfusion Medicine, Pittsburgh;
Associate Professor of Pathology
Department of Pathology
University of Pittsburgh
Pittsburgh, PA, USA

Jaap J. Zwaginga MD, PhD
Senior Lecturer
Jon J. van Rood Center for Clinical Transfusion
Research
Sanquin, Leiden and The Department of
Immunohematology and Blood Transfusion
Leiden University Medical Center
Leiden, The Netherlands

Preface to the Fourth Edition

The pace of change in transfusion medicine is relentless with new scientific and technological developments, and continuing efforts to improve clinical transfusion practice and avoid the use of blood wherever possible. This fourth edition has become necessary because of rapid changes in transfusion medicine since the third edition was published in 2009.

The primary aim of the fourth edition remains the same as the first, that is to provide a comprehensive guide to transfusion medicine. The book aims to include information in more depth than contained within handbooks of transfusion medicine and to present that information in a more concise and 'user-friendly' manner than standard reference texts. The feedback we receive from reviews and colleagues is that this objective continues to be achieved and that the book has a consistent style and format. We have again strived to maintain this in the fourth edition to provide a text that will be useful to the many clinical and scientific staff, both established practitioners and trainees, who are involved in some aspect of transfusion medicine and require an accessible text.

We considered that the book had become big enough for its purpose, and the number of chapters has been reduced by one from 49 to 48. It is divided into seven sections, which systematically take the reader through the principles of transfusion medicine, the complications of transfusion, practice in blood centres and hospitals, clinical transfusion practice, alternatives to transfusion, cellular and tissue therapy and organ transplantation and the development of the evidence base for transfusion. The final chapter on 'Scanning the future of transfusion medicine' has generated much interest, and it has been updated for this edition.

We wish to continue to develop the international readership and are very pleased to welcome Professor Nancy Heddle as a co-editor. The authorship likewise has become more international with each successive edition to provide a broad perspective. We are very grateful to the colleagues who have contributed to this book at a time of continuing challenges and change. Once again, we acknowledge the enormous support we have received from our publishers, particularly Jennifer Seward and Maria Khan.

Contents

List of contributors, ix

Preface to the Fourth Edition, xvi

- 1 Introduction: recent evolution of transfusion medicine, 1
Paul M. Ness

Part One: Basic Principles of Immunohaematology

- 2 Essential immunology for transfusion medicine, 11
Jaap Jan Zwaginga & S. Marieke van Ham
- 3 Human blood group systems, 21
Geoff Daniels
- 4 Human leucocyte antigens, 31
Cristina V. Navarrete
- 5 Platelet and neutrophil antigens, 45
David L. Allen, Geoffrey F. Lucas & Michael F. Murphy

Part Two: Complications of Transfusions

- 6 Investigation of acute transfusion reactions, 65
Kathryn E. Webert & Nancy M. Heddle
- 7 Haemolytic transfusion reactions, 77
Edwin J. Massey, Robertson D. Davenport & Richard M. Kaufman
- 8 Febrile and allergic transfusion reactions, 89
Mark K. Fung & Nancy M. Heddle
- 9 Acute lung injury after transfusion, 97
Steven H. Kleinman & Ram Kakaiya
- 10 Purported adverse effects of transfusion-related immunomodulation and of the transfusion of 'old blood', 106
Eleftherios C. Vamvakas
- 11 Transfusion-associated graft-versus-host disease and microchimerism, 116
Beth H. Shaz, Richard O. Francis & Christopher D. Hillyer
- 12 Posttransfusion purpura, 127
Michael F. Murphy
- 13 Transfusion-transmitted infections, 132
Roger Y. Dodd & Susan L. Stramer
- 14 Bacterial contamination, 144
Sandra Ramírez-Arcos & Mindy Goldman

- 15 Variant Creutzfeldt–Jakob disease, 152
Marc L. Turner
- 16 Emerging infections and transfusion safety, 161
Roger Y. Dodd

Part Three: Practice in Blood Centres and Hospitals

- 17 Regulatory aspects of blood transfusion, 171
William G. Murphy, Louis M. Katz & Peter Flanagan
- 18 The role of haemovigilance in transfusion safety, 181
James P. AuBuchon & Katharine A. Downes
- 19 Donors and blood collection, 190
Ellen McSweeney & William G. Murphy
- 20 Blood donation testing and the safety of the blood supply, 201
Richard Tedder, Simon J. Stanworth & Mindy Goldman
- 21 Production and storage of blood components, 209
Rebecca Cardigan & Stephen Thomas
- 22 Medicolegal aspects of transfusion practice, 224
Patricia E. Hewitt
- 23 Blood transfusion in hospitals, 230
Erica M. Wood, Mark H. Yazer & Michael F. Murphy
- 24 Blood transfusion in a global context, 250
David J. Roberts, Alan D. Kitchen, Stephen Field, Imelda Bates & Jean Pierre Allain

Part Four: Clinical Transfusion Practice

- 25 Inherited and acquired coagulation disorders, 263
Vickie McDonald & Samuel J. Machin
- 26 Massive blood loss, 276
Beverley J. Hunt & John R. Hess
- 27 Good blood management in acute haemorrhage and critical care, 284
Gavin J. Murphy, Nicola Curry, Nishith Patel & Timothy S. Walsh
- 28 Haematological disease, 300
Lise J. Estcourt, Simon J. Stanworth & Michael F. Murphy
- 29 Blood transfusion in the management of patients with haemoglobinopathies, 314
David C. Rees
- 30 Heparin-induced thrombocytopenia, 322
Andreas Greinacher & Theodore E. Warkentin
- 31 Immunodeficiency and immunoglobulin therapy, 335
Siraj A. Misbah

- 32 Fetal, neonatal and childhood transfusions, 347
Irene Roberts, Naomi Luban & Helen V. New
- 33 Recombinant proteins in diagnosis and therapy, 368
Marion Scott

Part Five: Alternatives to Transfusion

- 34 Principles of patient blood management, 379
Aryeh Shander & Lawrence Tim Goodnough
- 35 Autologous transfusion, 390
Dafydd Thomas, Bidy Ridler & John Thompson
- 36 Blood substitutes, 399
David J. Roberts & Chris V. Prowse
- 37 Pharmacological agents and recombinant activated factor VIIa, 410
Beverley J. Hunt & Simon J. Stanworth

Part Six: Cellular and Tissue Therapy and Organ Transplantation

- 38 Regulation and accreditation in cellular therapy, 421
Derwood H. Pamphilon & Zbigniew M. Szczepiorkowski
- 39 Stem cell collection and therapeutic apheresis, 433
Khaled El-Ghariani & Zbigniew M. Szczepiorkowski
- 40 Haemopoietic stem cell processing and storage, 443
Ronan Foley & Pamela O'Hoski
- 41 Haemopoietic stem cell transplantation, 455
I. Grant McQuaker & Ian M. Franklin
- 42 Cord blood transplantation, 464
Rachael Hough
- 43 Recent advances in clinical cellular immunotherapy, 473
Mark W. Lowdell & Emma Morris
- 44 Tissue banking, 480
Akila Chandrasekar, Paul Rooney & John Kearney

Part Seven: Development of the Evidence Base for Transfusion

- 45 Observational and interventional trials in transfusion medicine, 491
Alan Timmouth, Dean Fergusson & Paul C. Hébert
- 46 Getting the most out of the evidence for transfusion medicine, 505
Simon J. Stanworth, Susan J. Brunskill, Carolyn Doree, Sally Hopewell & Donald M. Arnold

CONTENTS

- 47 Variation in transfusion practice and how to influence clinicians' use of blood in hospitals, 516
Simon J. Stanworth, J.J. Francis, Michael F. Murphy & Alan T. Tinmouth
- 48 Scanning the future of transfusion medicine, 524
Dana V. Devine, Walter H. Dzik & Zbigniew M. Szczepiorkowski
- Index, 537
- Colour plate section can be found facing page 432*

Introduction: recent evolution of transfusion medicine

Paul M. Ness

Transfusion Medicine Division, Johns Hopkins Medical Institutions, Baltimore, Maryland, USA

Introduction to the introduction

‘May you live in interesting times’ (attributed to an ancient Chinese proverb).

This quotation, sometimes referred to as the Chinese curse, seems to be an appropriate statement to introduce the fourth edition of *Practical Transfusion Medicine*. Although it has been attributed to an unknown ancient Chinese proverb, its origin has not been determined, its attribution remains unclear and several of my Chinese colleagues suggest that it does not sound like a saying that emanated from China. One theory suggests that an original proverb translated to say ‘It’s better to be a dog in a peaceful time than be a man in a chaotic period’ may be the origin and additional Wikipedia information suggests sources from the *American Society of International Law Proceedings* in 1939, or attributions to Polish or Jewish roots.

Regardless of its source, this curse has become a blessing readily demonstrated by the growth of transfusion medicine as witnessed by the evolution of *Practical Transfusion Medicine* into this fourth edition. The transfusion medicine world has used transformational problems such as the HIV epidemic and growing concerns of patients and physicians about blood safety to address and anticipate transfusion-related problems. Physicians now seek evidence that our current and evolving practices are based upon

a solid foundation. This current volume has evolved from its humble original purpose to provide transfusion medicine educational material for haematology trainees in the United Kingdom (the first edition in 2001 through subsequent editions in 2005 and 2009) to become a comprehensive text with a distinguished international cast of authors. Former editions of the text have described the developing and broadening field of transfusion medicine for a multidisciplinary group of primary transfusion medicine practitioners to an increasingly diverse group of clinicians and supporting personnel dependent upon our services. This fourth edition continues the documentation of this movement to enhance blood safety and evaluates a growing armamentarium of options for blood and cellular therapies, based upon a foundation of evidence that continues to look forward but also has looked backward to substantiate or refute practices of the past. The transitions documented in the past ten years of the book’s history have not always been easy or straightforward, but readers of the text will understand that the transfusion medicine community has addressed the challenges of the curse of ‘interesting times’ and turned them into enhanced patient care opportunities.

Modern transfusion therapy would not be possible without the discoveries of the heterogeneity of blood group antigens by pioneers such as Landsteiner, Levine and Wiener, the development of anticoagulant preservative solutions for red cells stimulated