UNIVERSITY MEDICAL TEXTS

General Editor
SELWYN TAYLOR D.M., M.CH.(OXON), F.R.C.S.

A Short Textbook of Medicine Fifth edition
J. C. HOUSTON M.D., F.R.C.P.
C. L. JOINER M.D., F.R.C.P.
J. R. TROUNCE M.D., F.R.C.P.

A Short Textbook of Surgery Fourth edition
SELWYN TAYLOR D.M., M.CH., F.R.C.S.
L. T. COTTON M.CH., F.R.C.S.

A Short Textbook: Ear, Nose and Throat Second edition
R. PRACY F.R.C.S.
J. SIEGLER M.B., B.S., F.R.C.S., D.L.O.
P.M. STELL M.B., F.R.C.S.

A Short Textbook of Chemical Pathology Third edition
D. N. BARON M.D., D.SC., F.R.C.P., F.R.C.PATH.

A Short Textbook of Orthopaedics and Traumatology Second edition
J. N. ASTON M.B., F.R.C.S.
S. HUGHES F.R.C.S.

A Short Textbook of Psychiatry Second edition
W. L. LINFORD REES B.SC., M.D., F.R.C.P., D.P.M.

A Short Textbook of Venereology Second edition
R. D. CATTERALL F.R.C.P.(EDIN.)

A Short Textbook of Medical Microbiology Third edition
D. C. TURK D.M., M.R.C.P., F.R.C.PATH.
I. A. PORTER M.D., F.R.C.PATH.

A Short Textbook of Gynaecology and Obstetrics
G. D. PINKER M.D., F.R.C.S., F.R.C.O.G.
D. W. T. ROBERTS M.CHIR., F.R.C.S., F.R.C.O.G.

A Short Textbook of

Medical Statistics

Sir Austin Bradford Hill

C.B.E., D.Sc., Ph.D., Hon. D.Sc. (Oxon.), Hon. M.D. (Edin.), F.F.C.M. (Hon.), F.R.C.P. (Hon.), F.R.S.

Professor Emeritus of Medical Statistics in the University of London; Past Honorary Director of the Statistical Research Unit of the Medical Research Council; Past President of the Royal Statistical Society; Civil Consultant in Medical Statistics to the Royal Navy and the Royal Air Force

HODDER AND STOUGHTON
LONDON SYDNEY AUCKLAND TORONTO
In association with The Lancet

1977

To F. M. H.

ISBN 0 340 21957 2 Boards
ISBN 0 340 21958 0 Unibook

First published as Principles of Medical Statistics 1937
Ninth edition 1971
A Short Textbook of Medical Statistics
First published 1977

Printed in Great Britain for
Hodder and Stoughton Educational,
a division of Hodder and Stoughton Limited,
Mill Road, Dunton Green, Sevenoaks, Kent.

Text set in 11 pt Photon Imprint printed by photolithography, and bound in Great Britain at The Pitman Press, Bath

Editor's Foreword

'Books must follow sciences, and not sciences books' Francis Bacon

It is a splendid tribute to the University Medical Texts that Sir Austin's classic on Medical Statistics should now be joining them. This compact introduction to statistical method so appropriately renamed A Short Textbook of Medical Statistics first appeared in 1937. The intervening forty years have only served to reaffirm its excellence, albeit through many new editions all skilfully revised and brought up to date by the author.

Sir Austin has again entirely revised this new edition and for good measure included in his text two guides to the ethics of medical investigation, the Helsinki Declaration of the World Medical Assembly and the Medical Research Council's Statement on Responsibility in Investigations on Human Subjects. I welcome the inclusion of these since it will make them readily available in the laboratories and departments of hospitals and medical schools, few of which can afford to be without this little classic.

Even today students of medicine and its associated disciplines are given very little instruction in statistical methods. This small book is an ideal guide for the beginner and a most welcome reference work for those who need to refresh their memories in the field of medical statistics.

Selwyn Taylor

Royal Postgraduate Medical School,
Hammersmith Hospital,
London W.12.

Preface

The re-setting of this book in a new format has given me the opportunity to revise the text extensively and, I hope, beneficially. It was that hope, of course, that led me to make many changes throughout the book, in words and phrases, paragraphs and sentences, tables and pages.

I have also made many additions, major and minor. The former includes the introduction of two distribution-free (or non-parametric) tests of significance (Chapter 12); a brief discussion of the concept of multiple regression (Chapter 16); a more detailed illustration of the value of matched pairs of patients in a clinical trial, and also of the value of a design to assess the effects of more than one treatment and of the interactions of such treatments (Chapter 20). In this setting of clinical trials I have tried to emphasise the dominance of the ethical problems by bringing to the end of Chapter 20 what was previously relegated to an appendix, namely the Medical Research Council's statement on Clinical Research and the Declaration of Helsinki of the World Medical Association (1975 revision). A note on the relevant reports of the Royal College of Physicians has also been included.

With reference to the life table (Chapter 18) I have added short sections on the cohort table and on the uses of the life table in circumstances other than life and death. Two new 'fallacies and difficulties' relate to the self-selection of patients with migraine (Chapter 21) and to some problems in family history taking (Chapter 23).

I have deliberately left untouched much of the arithmetic that illustrates the development and use of each statistical method. I am, of course, not unmindful that these calculations would be performed today on an electronic calculator or computer (I have added a note on the latter to Chapter 1). But to get the right answer one must know how to ask a machine precisely the right question. Furthermore, and even more important, if one is to use a method intelligently one needs to understand the *ideas* underlying that method. And for these purposes a knowledge of the basic arithmetic is, I believe, essential.

Four tables for tests of statistical significance are given at the end of

the book. Those of t and χ^2, given in previous editions, have now been recalculated, and the latter is set in a rather simpler form. The other two tables have been added to this edition, for use in the two distribution-free methods of analysis now introduced. Lastly, in case they have been overused, I have replaced my previous tables of random sampling numbers with an entirely new set of some 5000 digits. I am greatly indebted to my son, Dr. I. D. Hill, for providing these random sampling numbers and for calculating the required values for the four tables for significance tests referred to above. Without his aid in this respect I should have been both helpless and hopeless. Moreover he has personally made valuable improvements and additions to this revised text.

Some time ago I read a book review which said that 'statisticians always start with some assumptions about their data, notably that these are accurate enough and consistent enough to justify the application of the statistical methods. Unless the statisticians are themselves closely familiar with medical practice they cannot be adequate critics of their own assumptions. Someone who knows medicine from inside, and statistics as well, must have a hand in the business.' I agree. The doctor himself, whether in clinical or preventive medicine, must have a 'hand in the business'. Indeed, my object in writing this book was to encourage just that. I sought to encourage those who know 'medicine from inside' to cultivate statistical ideas and elementary statistical methods. I hope that this revised and extended edition will continue to fulfil that function.

1977 Austin Bradford Hill

Contents