The Design and Statistical Analysis of Animal Experiments

Written specifically for animal researchers, this is the first book to provide a comprehensive guide to the design and statistical analysis of animal experiments. It has long been recognised that the proper implementation of these techniques can help to optimise the number of animals used in an experiment. By using real-life examples to make them more accessible, this book explains the statistical tools that are routinely employed by practitioners.

A wide range of design types are considered in detail, including block, factorial, nested, crossover, dose-escalation and repeated measures. Alongside each design, techniques are introduced to analyse the experimental data generated. Each analysis approach is described in non-mathematical terms, helping readers without a statistical background to understand key techniques such as: *t*-tests, ANOVA, repeated measures, analysis of covariance, multiple comparison tests, non-parametric methods and survival analysis.

This is also the first text to describe technical aspects of InVivoStat, a powerful open-source software package developed by the authors to enable animal researchers to analyse their data and obtain informative results. InVivoStat can be downloaded at www.invivostat.co.uk.

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To

RB, NRB, MTB, EC, EJC, ZMC

Contents

Preface

This book is aimed at practitioners who do not have a statistics degree and yet wish to apply statistics to help them arrive at valid and reliable conclusions while minimising the animal numbers required. Descriptions of the mathematical methods underpinning the topics covered in the book are purposefully kept to a minimum. If readers wish to gain a better understanding of the mathematics behind experimental design and statistical analysis then reading a more advanced textbook would help further their understanding.

The solutions to practical problems encountered when conducting animal experiments are explained using non-technical approaches. We believe that in many situations advanced statistical ideas can be employed successfully by researchers with no statistical qualification, using a combination of common sense and modern statistical analysis software packages. In our experience statistical ideas are often introduced to scientists using mathematical terminology. This can be off-putting to non-mathematicians and can leave researchers with, at best, only rudimentary statistical tools and at worst a fear of statistics.

To keep the descriptions of the statistical tools covered in this book as simple as possible, we shall occasionally give pragmatic explanations. While such explanations may not apply in all cases and in all scientific disciplines, this approach does allow us to introduce methods in a clear and concise way. By allowing ourselves the freedom to simplify the problems pragmatically, we aim to make statistical tools more accessible. The reader is invited, once they have familiarised themselves with (and hopefully found the benefit of using) the tools described in this book, to read more advanced texts on the subject.

This book is divided into seven chapters which loosely correspond to the procedure a researcher should take when planning the experimental design, running the experiment and evaluating the data generated. Following an introductory chapter and a second describing certain statistical concepts, the third chapter covers different types of designs. Designs are outlined, where possible, in simple non-technical language. This is followed by a chapter describing the randomisation of the experimental material. The fifth chapter discusses the statistical analysis of animal experiments and this is followed by a chapter describing how these methods can be applied within the statistical software package InVivoStat. The final chapter draws some conclusions about the ideas contained within the text.

A scientist can apply all of the methodology described in this book. Certain topics covered are more advanced than others and while we aim to make all subjects accessible, the reader should be aware that the help of a professional statistician may be advisable when first implementing some of the more advanced tools. However, once the readers have familiarised themselves with the ideas contained within this book, we hope they will have a fuller appreciation of the help statistics can offer to improve the conclusions that can be made when running animal experiments.

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Special thanks also to the statisticians who have advised us over the years and shaped our views on this subject matter. Simon would especially like to thank Philip Overend and Andrew Lloyd for their input and encouragement and Janet and Ed Godolphin for their help and support over the years.

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Finally we would like to thank our friends and family for putting up with the long unsociable hours we spent writing this book.