Statisticians are engaged in an exhausting but exhilarating struggle with the biggest challenge that philosophy makes to science: how do we translate information into knowledge? Statistics tells us how to evaluate evidence, how to design experiments, how to turn data into decisions, how much credence should be given to whom to what and why, how to reckon chances and when to take them. Statistics deals with the very essence of the universe: chance and contingency are its discourse and statisticians know the vocabulary. If you think that statistics has nothing to say about what you do or how you could do it better, then you are either wrong or in need of a more interesting job. Stephen Senn explains here how statistics determines many decisions about medical care, from allocating resources for health, to determining which drugs to license, to cause-and-effect in relation to disease. He tackles big themes: clinical trials and the development of medicines, life tables, vaccines and their risks or lack of them, smoking and lung cancer and even the power of prayer. He entertains with puzzles and paradoxes and covers the lives of famous statistical pioneers. By the end of the book the reader will see how reasoning with probability is essential to making rational decisions in medicine, and how and when it can guide us when faced with choices that impact on our health and even life.
Dicing with Death
Chance, Risk and Health

STEPHEN SENN
University College London
For Victoria, Helen and Mark
...the twain were casting dice
'The game is done! I've won! I've won!'
Quoth she and whistles thrice.

Coleridge, *The Rime of the Ancient Mariner*
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"What's the most frequent word?" asks Jessica. "Your number one. The same as it's always been at these affairs," replies the statistician, as if everyone knew: 'death'.

Statistics is dull but disreputable, prosaic but misleading. Statisticians are the auditors of research: negative and uncreative book-keepers. If mathematics is the handmaiden of science, statistics is its whore: all that scientists are looking for is a quick fix without the encumbrance of a meaningful relationship. Statisticians are second-class mathematicians, third-rate scientists and fourth-rate thinkers. They are the hyenas, jackals and vultures of the scientific ecology: picking over the bones and carcasses of the game that the big cats, the biologists, the physicists and the chemists, have brought down.

Statistics is a wonderful discipline. It has it all: mathematics and philosophy, analysis and empiricism, as well as applicability, relevance and the fascination of data. It demands clear thinking, good judgement and flair. Statisticians are engaged in an exhausting but exhilarating struggle with the biggest challenge that philosophy makes to science: how do we translate information into knowledge? Statistics tells us how to evaluate evidence, how to design experiments, how to turn data into decisions, how much credence should be given to whom to what and why, how to reckon chances and when to take them. Statistics deals with the very essence of the universe: chance and contingency are its discourse and statisticians know the vocabulary. If you think that statistics has nothing to say about what you do or how you could do it better, then you are either wrong or in need of a more interesting job.
If you tend to the first of these views, this book is written to persuade you of the truth of the second and if you already accept the second it is here to confirm your faith. Statistics is all-pervading in science but it is also misunderstood. The non-scientist in the street probably has a clearer notion of physics, chemistry and biology than of statistics, regarding statisticians as numerical philatelists, mere collectors of numbers. The truth must out, and I am determined to out it and this book is how I have chosen to reveal it, but in a book like this it would be impossible to tell it all. Even within my own field of application, medical statistics, I cannot do that. There are many matters I should like to have covered but have not: the logic, or otherwise, of screening for disease, the use of statistics in health-care planning, statistical approaches to the creation of expert systems for diagnosis, the wonderful science of decision analysis and its application to selecting which drugs to develop, the world of sample surveys, the mathematics of genetics, the statistical approach to quality control and its application to monitoring surgery, the interpretation of hospital league tables, sequential analysis and the design of experiments.

Nevertheless, we shall cover some important matters: paradoxes in probability, significance tests, clinical trials, the Bayesian and frequentist schools of inference, the generalisability of results, the safety, or otherwise, of medicines and tobacco, life-tables and survival analysis, the summarising of evidence, the mathematics of measles, and even the application of statistics to the law. (If the relevance of the last of these to medical statistics is not clear, all will be revealed in Chapter 10.) Naturally I am convinced that this is all good stuff but some of it, I know, is strong medicine. I have tried to sugar the pill by coating the numerical with the biographical. We shall discuss not just statistics the subject but the statisticians who created it and a curious lot they turn out to be. We shall also, occasionally, take some strange diversions and the medically qualified reader may detect the symptoms of knight’s-move thought (kmt) and conclude that the author is schizophrenic. (It must surely have been someone with kmt who first called it kmt.) But despite these diversions, whether biographical or otherwise, the numerical cannot be entirely avoided. I have helped the reader to spot it by spotting it myself, or at least staring it. There are two starred chapters, and these are more demanding than the rest. They can safely be omitted by those who find the mathematics off-putting, although, of course, I would not have included them if I had not felt that they were worth the struggle. A star attached to a section within a chapter
also indicates more difficult material that can be skipped. A starred section within a starred chapter is for the top of the class.

I make no claims to omniscience. Statistics is the science of inference, the science of inference for science, and the defining characteristic of science is not its infallibility but its self-correcting ability. Some of what I say will need correcting. Although I have done some original historical research myself, this is limited to the first half of the last century and even there it is limited to a small part of the story. Elsewhere I have relied extensively on secondary sources, in particular the magnificent books by Anders Hald and Stephen Stigler.1 Other sources are indicated in the footnotes to the chapters. I have also strayed into areas in which I have no particular expertise, the modelling of infectious diseases and statistics applied to the Law, for example. The subject is so vast that nobody can be expert in all aspects of it. My own personal research is mainly in the design and analysis of clinical trials but the book needed more than just that to give it wings.

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So on with the book. I am going to try and convince you that when it comes to making decisions and scientific inferences, if you can’t count you don’t count. Let us roll the first die.

Permissions