DEMYSTIFYING STATISTICS AND RESEARCH FOR OPHTHALMIC INVESTIGATORS

Organizers: Gabriela Czanner, PhD, CStat, Sarah E. Coupland, MBBS, PhD, FARVO and Bruce I. Gaynes, OD, PharmD

Many well-intended clinical studies lack appropriate study design and assessment of study power. Significant study findings are often later discounted due to these poor study designs. To compound the problem, statistical principles are not well understood and clinicians and statisticians do not always agree on the best methods to use. Concepts such as significance and p-values are being debated internationally. The Pearson correlation coefficient is often used incorrectly. Estimating the effect of treatment in studies with baseline and follow-up is not widely understood. This course brings together clinicians and statisticians to address these challenges. At the end of this course, you will understand what is wrong with correlation coefficients, what a confidence interval actually represents, the key elements of a sample size calculation and a lot more. The course will focus on understanding statistical fundamentals and the correct interpretation of ophthalmic data. Examples of what-not-to-do and why will be discussed. Formulae will be kept to a minimum - so no calculators needed!

Introduction and Welcome

Gabriela Czanner, PhD, CStat, Merseyside Group, University of Liverpool

This presentation will be a general overview of the day.

Introduction to research theory: The research hypothesis

Bruce I. Gaynes, OD, PharmD, Loyola University

This talk will introduce the approach to hypothesis testing as applied to clinical research. The discussion will introduce the concept of inference and falsifiability as applied to hypothesis testing. The characteristics of a thoughtful clinical research hypothesis will be discussed.

Deductive vs. inductive reasoning and study design

Bruce I. Gaynes, OD, PharmD, Loyola University

What is the most appropriate strategy for your clinical study? This talk will present approaches to clinical research that encompass either deductive hypothesis based study vs. inductive naturalistic research strategy. The basis and importance of naturalistic research as it pertains to clinical study will be explained. Concepts of predictive analytic strategy for clinical study will be introduced.

Understanding study power and fundamental statistical principles for clinical research

Bruce I. Gaynes, OD, PharmD, Loyola University

This discussion will address facets of study power and elements of statistical analysis pertinent to clinical research. The talk will include the concept of effect size and the relationship between the tested hypothesis, sample size and statistical approaches for presentation of study findings. Strategy to improve the validity of small pilot clinical research study will be emphasized.

Selection of study subjects and sampling

Bruce I. Gaynes, OD, PharmD, Loyola University

This discussion will address methodology for selecting a population sample for clinical research. We will introduce the concept of probability sampling and discuss why simply noting inclusion and exclusion criteria overlooks elements of study selection necessary to reduce sampling bias.

Sample size calculations

Bruce I. Gaynes, OD, PharmD, Loyola University

This presentation will introduce the principles of sample size calculations. This will be done via example of a two-sample t-test. We will explain type I and II errors. We show how a sample size statement can be structured for a grant application. We give also a list of resources: links to online calculator and links to guidelines of leading journals.

Data management – how should I collect data during my study?

Catey V. Bunce, PhD, Kings College, London, National Institute for Health Research Biomedical Research Centre at Moorfields Eye Hospital NHS Foundation Trust and the UCL Institute of Ophthalmology

In order for your study to answer your research question, it is likely that you will wish to conduct statistical analysis. Statistical analysis can be straightforward if your data have been captured in the correct format. My talk will outline the format that is typically required by statisticians for timely analyses. I will provide examples of data that have been captured in a sub-optimal format, which would require extensive data cleaning prior to analysis. Data cleaning can be very time consuming and this talk will provide helpful tips as to what to avoid so that your research provides result in a prompt fashion so benefiting the patients who have taken part in your studies.

Statistics: What are the 10 things that I need to know about statistics in ophthalmology? Choosing correct methods and interpretation

Gabriela Czanner, PhD, CStat, Merseyside Group, University of Liverpool

This presentation will review 10 statistical concepts. Topics included will be: descriptive vs inferential statistical methods and why we need them both; types of measurements and how we decide on the best statistical method for each type; what is clinical and statistical significance; how we decide on the statistical method depending on one or two eyes being measured; basic statistical methods for comparisons via categorical and continuous measurements; statistical methods to assess association; and correlation and statistical modelling. In each topic, we will provide tips for analysis and interpretation.

Fuss about p-value: How do I compare two treatments? Why is the p-value never enough?

Ana Quartilho, MSc, National Institute for Health Research Biomedical Research Centre at Moorfields Eye Hospital NHS Foundation Trust and the UCL Institute of Ophthalmology

This presentation will cover a formal statistical definition of p-value and confidence interval. Emphasis will be placed on translating such definitions into the underlying accurate real-world meaning. An applied ophthalmic example of statistical comparison between two treatments will be presented. The rationale for what information a p-value on its own hides, will then follow straightforwardly. We will also discuss how the p-value should be reported for publication.

Appraisal of research papers: How do I read and review research papers?

Marta Garcia-Finana, PhD, University of Liverpool

This presentation will focus on how to appraise the research published in scientific journals. We will discuss the main aspects that need to be taken into account when reading a paper, such as the aim of the study and research hypotheses to be tested, primary outcome, unit of analysis, whether correction for multiple comparisons should be applied, method of analysis and interpretation.

Missing data: How do I analyse data if there are missing values? Does it matter what method I chose?

Ana Quartilho, MSc, National Institute for Health Research Biomedical Research Centre at Moorfields Eye Hospital NHS Foundation Trust and the UCL Institute of Ophthalmology

This presentation will cover scenarios where data are missing. We will highlight how missing data can impact your study and discuss that, although sophisticated statistical methods exist for missing data, avoidance of missing data at the onset is of utmost importance. Tips for preventing missing data and guidance on how to report missing data in publication will be provided.