B170 Imparting a Meaningful Application of Statistics to Forensic Scientists

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After attending this presentation, attendees will understand that statistical education is fundamental to the proper analysis of scientific data, including that generated by forensic laboratories. Understanding the meaning and appropriate application of statistics is vital if conclusions reached are to have validity. This presentation will discuss the examples of inappropriate and appropriate statistics that should be considered essential knowledge for the practicing forensic scientist.

This presentation will impact the forensic science community by discussing approaches to addressing inadequate applications and interpretations of statistics in forensic science by providing examples of appropriate usage and highlighting selected pitfalls in statistical methodology and interpretation.

The book, How to Lie with Statistics, states that "anything smacking of the medical profession" (or backed by scientific laboratories) is worthy of trust.[1] H. G. Wells once said, "Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write." The assault on inappropriate statistical thinking in forensics began in 2004 with the National Academy of Sciences (NAS) Report on bullet lead comparisons.[2] The following 2009 National Academy of Sciences (NAS) Report, Strengthening Forensic Science in the United States – A Path Forward, emphasized validation of forensic measurements and estimation of uncertainty of measurements to understand sources of bias/error in forensic science.[3] Just substitute "forensic scientists" for "efficient citizenship" in the Wells quote. The day is now — trust is no longer unconditional.

Education in applicable statistics is a first step. Accreditation Standards of the American Academy of Forensic Sciences (AAFS) Forensic Science Education Programs require "…at least one course in statistics (three semester hours)." There is no mention of statistics applicable to forensic practice, but budding forensic scientists have exposure to method validation in the suggested instrumental analysis course. What about a meaningful discussion of reporting confidence intervals instead of p-values, of differences between a p-value, a size effect, or a likelihood ratio; or of the fact that at a limit of detection defined by the concentration equivalent to a signal that is three standard deviations of the blank measurement higher than the average blank signal, the false positive detection rate is 50%. Houck was perhaps concerned with the "tyranny of numbers" when he wrote, "This expectation (to apply statistics) is fraught with pitfalls that could adversely affect the accuracy of evidentiary reports presented in court. The foundational data upon which trace evidence statistics might be based differ radically from those used in DNA statistical calculations. If statistics are to be applied to trace evidence, they must be applied in a way appropriate to the discipline, unbiased in interpretation, and accessible to the trier of fact".[4] Reinhart believes the problem is poor statistical education.[5] Ioannidis makes the case that even established medical scientists have issues with positive predictive value (i.e., research producing false positive outcomes).[6]

Lack of knowledge of appropriate statistics in various disciplines is not uncommon. Medical students are required to take a course in statistics, yet medical residents apparently average less than 50% correct on questions concerning statistical tests used in medicine.[7] Most forensic validation documents are now citing appropriate statistical methodology; however, few show worked examples of appropriate data treatment for determining uncertainties or offer interpretations of the statistical outcomes. At this time, there is a need for statistical tools that are designed and fit-for-purpose in forensic application. How does the community get from here to where it should be is the question raised in this presentation.

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Statistics, Applicability, Interpretation