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LETTERS TO THE EDITOR

Correspondence on Statistics articles series by Drummond and colleagues

Our series of articles on Statistics relevant to Pharmacology and related disciplines by Drummond and colleagues has attracted correspondence as we expected it might. The full series of Statistics articles and the correspondence can be found at http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1476-5381/homepage/statistical_reporting.htm

The latest correspondence is published below.

John C McGrath
Editor-in Chief, BJP

When biostatistics is a neo-inductionist barrier to science

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In a recent editorial (Drummond and Vowler, 2011b), the famous quote by R.A. Fisher berating the experimenter for only coming to the biostatistician for post-mortem examination, finding out only 'what the experiment died of' (Fisher, 1938) is reproduced apparently sympathetically. Given the ongoing criticism of scientists by biostatisticians (this refers to a series of perspectives on the use of statistics in pharmacology published in *British Journal of Pharmacology*: Drummond and Tom, 2011a,b; Drummond and Vowler, 2011a,b; Drummond and Tom, 2012; Drummond and Vowler, 2012; the links to all these papers can be found at: http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1476-5381/homepage/statistical_reporting.htm), it seems time that the case for the defence is made, and a scientist's criticism of biostatisticians be given.

The scientist could reply to the statistician, 'My experiment is not dead, the results are highly interesting, but quantification of the information is difficult, can you, doctor statistician, help me?' The reply could continue, 'I already know why my experiment is sick, it took the doing of the experiment to find that out, just like an engineer has to build a prototype to find the flaws in the design. If I thought you could have predicted in advance where the problems would arise, I would have contacted you then. But I am not so confident of your prescience, and guess that your confidence is born of the advantage of hindsight. In truth, the problems you see in my experiment were discovered by me, and brought to you. If you can tell me no more than to do the entire experiment again, when I already know I could do that (if I had the manpower and the money) and when you couldn't have predicted these problems either, then what good is your profession to a scientist? Can you tell the engineer ahead of time where the flaws will be in his design? If not, then what makes you think you can find the complexities in the subject matter of my experiment ahead of time?'

To a working scientist, the lectures of the statistician can sound hopelessly naïve, and even hubristic, betraying a platonic conception of experimentation, with experimental designs existing in an ideal realm that would be perfect if not for dirty reality. For a profession that is ostensibly about finding signals in a noisy world, statisticians seem strangely out of touch with the world. Real experimentation is a discovery process, an iterative error-correction process where the doing of an experiment identifies errors, confounds, and covariates that are then further controlled and tested anew. Errors are not simply manifest when a hypothesis is formed, to be carefully controlled for ahead of time, but are unpredictable and discovered in the physical and biological

unknowns of the experimental situation in the doing. To think otherwise is to ignore the very fallibility of the human species that experimentation seeks to correct. For example, a pharmacologist make discover part of the way through an experiment that some drug combination lead to an unexpected problem with solubility, and so the solvent concentrations are adjusted in some groups, adding another variable to the experiment. To say 'you should have thought of that before you started' is to sit on the sidelines and comment from the very hindsight provided by the actions of the experimenter. Unexpected problems are legion and quite unpredictable. If the statistician has no more to offer than to say 'start again and do it right this time', then he may get another visit from the scientist later, reporting another unexpected problem and adjustment mid-experiment.

The underlying issue was spelt out long ago by Sir Peter Medawar. His essay 'Is the scientific paper fraudulent?' (Medawar, 1964) should be required reading for all biostatisticians. Medawar was criticizing the way inductionism forces scientists to report their experiments in a misleading way. The neo-inductionism represented by the dictates of biostatistics as it is now conceived (both Frequentist and Bayesian) could very well lead to the opposite of intended results, forcing scientists to misleadingly contort their work to fit an even more inflexible inductionist schema. It needs to be remembered that the purpose of scientific publishing is to report interesting findings, not to provide credentials to a researcher or a research program. The scientist may have data that independent judgment perceives is clearly not random, qualitatively improbable observations (e.g. Ramachandran and Blakeslee, 1998) or patterns that are complex but discovered through a tortuous iterative experimental procedure; narratives that lack the symmetry beloved of mathematicians, and so are extremely difficult to quantify. If scientists stopped experimenting in this way, sticking to the inductionist fantasies of *a priori* programmatic experimental design beloved of funding agencies and statisticians, then the discovery process that is science will be severely compromised. A case could be made that where innovation occurs today, it is in spite of rather than because of statistical formalism; that progress is more likely to be made when experiments test bold hypotheses that are logically improbable in a way that is often not easily captured by statistics. Just as every inductionist attempt to make science a potentially automated and predictable set of procedures has failed in the past, so the neo-inductionist attempts of the present day by biostatisticians must similarly fail. Scientific discovery is not the same as operational research, and it is not that scientists have not caught up with statistics, but that statistics has still not caught up with the needs of scientists. While statisticians continue to lecture scientists from high alters of hindsight, as the scientists are busy getting their hands dirty in that dirty messy unpredictable real world, they may continue to find their lectures falling on deaf ears.

John C Ashton
Department of Pharmacology and Toxicology, School of Medical Sciences, University of Otago, Otago, New Zealand

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Response to 'When biostatistics is a neo-inductionist barrier to science'

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We can understand some of the sentiments expressed by Dr Ashton and agree that classical statistics considered in the early perspectives in the series are indeed inappropriate for some laboratory experiments. Our defence is that we addressed first the topics we believed were known to our readers, those that are still widely used and misused by scientists. Later perspectives introduce more relevant materials. We do not carry a particular torch for Fisher and his post-mortem, but we quoted him to make a specific point: one can usually tell, in retrospect, why the desired result cannot be 'obtained' from the data, and this is often because the experiment has been badly designed. In the case of good (or appropriate) design, as with beauty, appreciation is in the eye of the beholder. In statistics, as in art and science, opinions differ, often widely (Fisher certainly disagreed with many other statisticians). Most statisticians can recount horror stories of being presented with data from experiments that could have