



Lies, damn lies and statistics: Errors and omission in papers submitted to INJURY 2010–2012

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ABSTRACT

Introduction: Many reviews of published papers in the medical literature have reported errors in statistical methods and presentation.

Methods: 100 successive papers submitted to INJURY and sent for initial statistical review between December 2010 and January 2012 were analysed. The comments made on the papers were categorised and summarised.

Results: Suggestions for improvement were made for 90 of the papers. An inappropriate analysis was identified in 47. Other errors were seen in 45 papers including 9 wrong *p*-values for the method used. Simple numerical mistakes were common (19%). An inadequate description of some element of the study was a problem in 22 papers and additional limitations to be described in Discussion were recommended in 26. Numerically most comments were made about some element of the presentation of results.

Discussion: Many of the errors identified are easily avoided. Guidance on some common issues is presented.

Conclusions: Statistical and numerical errors are common in papers submitted to INJURY and requiring statistical review. Following the advice in Discussion and using reporting guidelines should reduce the number of papers requiring corrections.

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Introduction

Medical statistics is often considered a young discipline, though the use of statistical diagrams to present information pertaining to health certainly dates to Florence Nightingale with a series of publications in the 1850s.¹ Epidemiology also has its roots in that period with the pioneering work of John Snow on the modes of communication of cholera.² Modern medical statistics owes much to Austin Bradford Hill in the middle of the twentieth century. He brought the ideas of randomised experimentation and statistical inference into medicine from the agricultural areas where the methods had been developed. Since then the role of statistics in medical research has been expanding and evolving. The practice of medical statistics has been revolutionised by the growing availability of low-price computing and the development of statistical packages for analysis. Many of these packages are designed for easy access by statistical novices, bringing the possibility of conducting sophisticated statistical

analyses within the ambit of all researchers. This very positive development also has associated risks. It is now possible to present a totally erroneous analysis in a way that is superficially convincing.

Statistical review of papers in medical journals was quite unusual until a series of review papers from the 1970s onwards, demonstrated that a majority of papers in leading journals had worrying statistical errors. An early example showed that of 62 papers published in the British Medical Journal within the first quarter of 1976, 32 had errors while 5 actually came to false conclusions.³ Since then, statistical review has been an increasingly common feature of many medical journals and the major medical journals now ask for statistical review of all, otherwise acceptable, papers with a statistical content.

The requirement for papers to meet rising standards for their scientific and statistical content has been an impetus for the development of guidelines to help authors prepare their papers for publication. Randomised controlled trials were the first subject for such guidelines with the CONSORT statement, subsequently updated.⁴ This has been extended to also deal with cluster randomised trials.⁵ There are now also guidelines for diagnostic accuracy (STARD),⁶ meta-analysis (PRISMA⁷), and observational studies (STROBE)⁸ among others. The Council of Science Editors website is a good access point for guidelines.⁹

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Statistical guidelines are, of necessity, somewhat general. It is difficult to imagine that anyone will ever be able to anticipate all of the complexities that may arise in any research study, so a cookbook approach to statistics will always have its limitations. There are certain principles that should be followed, however, and Altman and colleagues were among the first to delineate these.¹⁰

The reviews of statistical quality have usually been restricted to published papers because of difficulty in gaining access to the original submissions. Thus, it is reasonable to anticipate that errors in the papers submitted to journals will be even higher than in the 'sanitised' versions that are published after peer review. Experience of reviewing papers for Injury indicates a broad spectrum of statistical expertise among authors. The purpose of this paper is to document the issues that have been raised during statistical review in order to provide potential authors with a better idea of the expectations of a statistical reviewer and to minimise the number of drafts before acceptance of their paper. Some errors are common and many of them are present in papers by authors who otherwise appear to have a fairly strong statistical background. We are hopeful therefore that even those who feel confident in their statistical abilities will take the time to consider these findings.

For those at the less experienced end of the spectrum, we hope this paper will help to put the statistical issues into a better perspective and help to de-mystify a subject which is widely regarded as 'difficult'. It is, of course, a subject that can readily become quite technical when applied to a complex data set. In these circumstances it is worth remembering this definition of the statistical method; it is a method for the elucidation of data that is affected by a multitude of causes. Statistics should be acting as an aid to understanding our data and then to facilitate the communication of that understanding to others. Non-statisticians may be surprised how often statistical reviewers suggest a reduction in the statistical content of a medical paper rather than suggest additional statistical work.

Methods

All papers submitted to one of the authors (RP) for blinded statistical review between December 2010 and January 2012 were included in the review, irrespective of whether or not the paper was subsequently published in INJURY. This period was chosen to give a sample size of 100 for convenience of presentation. The comments in the original statistical review were subsequently categorised by the same person, who is a medical statistician with 40 years of experience. These categories were used to build an expanding dictionary of the problems identified. After all papers had been initially coded, some categories were seen to be too broad for the purposes of this report. Papers in these categories were re-evaluated into more detailed categories. Finally the categories were organised into themes as presented in Table 1. The results were initially entered into an Excel database. These were transferred to IBM SPSS statistical software (version 19.0; SPSS Inc., Chicago, IL, USA) for analysis. The analysis is limited to simple descriptive statistics.

Results

Some suggestions for improving the paper were made in 90 of the 100 papers reviewed. Of these an inappropriate analysis of the kinds listed in Table 1 were identified in 47. The most common problem was the incorrect analysis of 2×2 contingency tables. There were 65 papers presenting such data and 14 (22%) used an unsuitable method.

As of much concern as the use of an inappropriate method of analysis is the presentation of erroneous results. This was detected in 45 papers (Table 1). Many tests of significance cannot be

Table 1

Problems identified on initial statistical review of a consecutive series of 100 submissions to INJURY.

	N
Inappropriate analysis	
Any of the following	47
• Of 2×2 contingency tables	14
• Tests on part of a contingency table	2
• Paired data analysed as independent	5
• Other lack of assumed independence	3
• Outcome variable used as predictor	3
• Erroneous sub-group analysis method	3
• No plausible Null Hypothesis	9
• Cut-point issues	4
• Miscellaneous	18
Errors	
Any of the following	45
• Wrong <i>p</i> -value for test performed	9
• Numerical errors	19
• Text and tables inconsistent	2
• Incorrect sample size calculations	4
• Methods section inconsistent with Results	9
• Erroneous interpretation of results	12
Inadequate descriptions	
Any of the following	22
• Unclear/inconsistent definition of patient groups	4
• Unclear who is included in analysis	3
• Numbers presented instead of rates	3
• Unclear description of statistical methods	5
• Which test is being used where	2
• Method of randomisation unclear	3
• Data unclear	4
Presentational issues	
Any of the following	73
• Use of \pm notation	26
• False precision	30
• $p = 0$	5
• Percentages without numbers	12
• Trailing zeros omitted	8
• Choice of % in 2 way classifications	3
• Inadequate labelling/legends for Figures	21
• Actual <i>p</i> -values not reported	9
• Inappropriate or no measures of dispersion	12
• Quartiles not reported when needed	6
• Absence of confidence intervals	4
• Inferior graphical presentation	5
• Loose statements (e.g. about 48%)	1
Miscellaneous	
• Additional limitations needed in Discussion	26
• Multivariate/multivariable	14
• Interpretation of 'independent' risk factors	4
• Multiple testing issues	7

checked for accuracy of reporting by a reviewer, so the 9 cases where the reported *p*-value could be shown to be in error for the test performed is likely to be an underestimate of the true prevalence. These included errors that would change the conclusions of the paper. Proportionately, the major error was in sample size calculation, where 4 of the 5 presented were incorrect. Numerical errors were found in 19 papers, ranging from incorrect percentages to numbers that were inconsistent. In another 2 papers, different information was presented in the tables and the text. The Methods section did not correspond to the Results in 9 papers. In 12 instances the analysis of the results were interpreted incorrectly.

In addition to the actual errors described above, there were 22 papers with an inadequate description of some elements of the study (Table 1). The detailed statistical review of these papers was, by necessity, limited to those sections that were adequately described. Although papers submitted to Injury are encouraged to discuss the limitations of the study, statistical review identified 26 papers with one or more additional limitation that should be mentioned.

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