Abstract: Fabricated data may exhibit unusual regular or irregular patterns, thus data fabrication may be potentially discoverable by statistical methods. We applied two established and one new method in examining data used in eight published papers and two NIH grant applications. Twenty-two attempts to replicate experimental results in two of these papers have failed. We examined data sets of numbers from Coulter counters and hand-counted colonies in more than 850 experiments by eight different investigators in one laboratory, including one investigator whose experiments were central in the aforementioned papers. Unusual patterns evident in the questioned investigator's data sets did not appear in data sets from other investigators. We developed a new technique for estimating the probability distribution of numbers of triplicate colony (or Coulter) counts that include their own average and used it and conventional tests to determine the significance of the anomalies. Applied to data from the questioned investigator these tests repeatedly resulted in rejection of null hypotheses that the anomalous patterns might have occurred by chance ($p < 0.001$, often much less). Our analysis underscores the importance of access to raw data used in publications and grant applications, in order to detect aberrant, anomalous, and (possibly) fabricated results.

Title: A forensic approach to analysis of data in cellular and radiation biology

Authors: Joel Pitt, Georgian Court University, Lakewood, NJ; Helene Z Hill, New Jersey Medical School, Newark, NJ

Key Words: data variability, data manipulation, statistical analysis, statistical forensics

Cover letter

Monday, December 17, 2012

Gerald Weissmann, MD, Editor-in-Chief
FASEB Journal

Dear Dr Weissmann,

Dr Joel Pitt and I would like to submit a manuscript entitled **A forensic approach to analysis of data in cellular and radiation biology** for consideration for publication in the FASEB Journal. We believe that it is appropriate for the **Life Sciences Forum**. We base this on the fact that in 2009, ML Hudes, JC McCann and BN Ames published in 2 parts an article with similar content entitled "Unusual clustering of coefficients of variation in published articles from a medical biochemistry department in India" FASB J 23:689-703 (2009); and JC McCann, ML Hudes and BN Ames "Part 2--- Unusual clustering of coefficients of variation in published articles from a medical biochemistry department in India" FASB J 23: 706-708 (2009). Their papers deal with an ever increasing challenge found in the scientific literature today: that of the need to analyze numerical results. Similar to their analysis, we analyze raw data that formed the background, at least in part, for 8 publications in peer-reviewed journals. The focus of those articles was to better understand the interactions of various radioactive isotopes with mammalian cells in order to estimate more precisely doses to be used in nuclear medicine applications for diagnosis, treatment and to set safety standards for healthcare and other workers exposed to radioisotopes.

The studies that we analyzed were supported by grants from the USPHS and the Department of Energy. Reliance on results – if incorrect -- reported in the 8 papers of concern to set doses and standards could result in harm to patients and/or to workers in nuclear medicine.

In the Hudes, McCann and Ames papers, data from questioned individuals were analyzed using statistical measures and compared, as controls, to similar studies that were found in the literature. Our analyses are analogous in that we perform the same tests on the raw data from the questioned individual and from (as controls) several others in the same lab recording results in the same manner, as well as data that we obtained from outside labs.

Hudes, McCann and Ames conclude "We are unable to offer a statistical or biological explanation for the unusual clustering observed". We come to a similar conclusion in that we are unable to explain the rather pronounced deviation of the questioned individual's results from the null hypotheses of random or uniform in the several tests that we performed, while the results of our comparison groups do conform to those null hypotheses. We are forced to conclude that the questioned individual's results cannot have come about by chance, in contrast to the variations found in the data of others which very well could be the result of chance.

In a more recent letter, McCann, Hudes and Ames (Anaesthesia 67: 1042-1043 (2012), referring to their studies in the FASEB Journal, conclude that "As evidence of fraud, small p values will never be as jazzy as, for example, obviously doctored photographs, but well-conducted statistical analyses may be the only way to uncover many types of fraudulent scientific evidence". In our analysis of the data in our hands, we applied published statistical methods such as terminal digit analysis and binomial probability analysis, but we noticed that, in the questioned individual's results, the rounded average of 3 replicate samples appeared frequently as one of the 3 entries. We devised a new statistical test to determine probabilities for this to occur. We believe our paper presents "well-conducted statistical analyses".

Dr Pitt has created an Excel spreadsheet that can be used to apply the statistical tests described in the paper to similar survival and count data of others. The spreadsheet should be of use to researchers in cell biology laboratories to check on the validity of their workers' results. The spreadsheet will be available at no charge.

The data we examined was available to me as stated in memos and regulations set forth by my university as I was a co-investigator in the laboratory in question, as well as a co-author on one of the papers that is under scrutiny.

It is also worthy of note that the Principal Investigator and a second post-doctoral fellow were unable to replicate results of 2 key experiments recorded in 2 of the questioned papers (I am a co-author on one of those papers) in spite of 22 attempts to do so. The results of the attempts to replicate the experiments in question were entirely consistent with radiobiological expectations for cell survival while the results reported in the papers are unlikely because the culture medium lacked a key ingredient that would have been necessary to produce the recorded survival kinetics.

We are particularly eager to publish our findings in the FASEB Journal because, in the case of the articles in your journal that were cited above, the authors of the questioned papers were given an opportunity respond. We applaud your journal for providing an open forum for such a response and we believe that the authors of the papers whose data we question should also be given an opportunity to respond.

We look forward to a favorable response to our initial query and to the ultimate publication of our results in the FASB Journal.

Sincerely yours,

Helene Z Hill, PhD

Helene Z Hill, PhD
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The response (within 4 hours)

MS ID: The FASEB Journal FASEBJ/2012/226688
MS TITLE: A forensic approach to analysis of data in cellular and radiation biology

Dear Dr. Hill:

Thank you for submitting the referenced initial query for our consideration.

I am sorry to report that this initial query did not receive high enough priority to
warrant further consideration for publication. We suggest that you submit this work
to an appropriate specialty journal.

Sincerely yours,

Gerald Weissmann, MD
Editor-in-Chief
The FASEB Journal