Scientific Misconduct: Tip of an Iceberg or the Elephant in the Room?

INTRODUCTION

Evidence-based dentistry requires quality evidence, but we seldom consider how “the evidence” is produced. Recently, very serious examples of scientific misconduct have received significant publicity in scientific circles (Odling-Smee et al., 2007), yet appear to have had little impact in dentistry (Luther, 2008, 2009; Smith, 2008), suggesting either a lack of awareness (Bosch, 2007) or possibly a certain tolerance (Bevaqua, 2007). But a recent survey (Martinson et al., 2005) and a meta-analysis (Fanelli, 2009) suggest that the few cases that do surface represent only the tip of a large iceberg. Indeed, it is suggested that if, on average, 2% of scientists admit to having falsified research at least once, and up to 34% admit other questionable research practices, the actual frequencies of misconduct could be higher than this (Fanelli, 2009). In addition, it appears that misconduct in clinical, pharmacological, and medical research is more widespread than in other fields, although the reasons for this are unclear (Fanelli, 2009). Given that images as well as data can be faked or manipulated, it seems timely to raise awareness of these matters and the means to address them.

This paper therefore:

- discusses recent examples of relevance to dentistry;
- draws attention to the new era of “digital forensics” (Farid, 2009), where new technology is being developed to help detect faked images; and
- considers what other steps can be taken to reduce scientific misconduct.

Scientific misconduct is not new, but increasingly competitive research and educational environments compound the pressure on authors, funders, and institutions to publish. Furthermore, electronic methods of faking data and images are increasingly available. Pressure may also be enhanced by measures such as the UK’s Research Assessment Exercise (now the Research Excellence Framework). This has a substantial effect on university department funding—which itself affects whether funding bodies are willing to support certain departments. Other countries may be considering similar assessments (Von Tunzelmann and Mbula, 2003).

HOW COMMON IS SCIENTIFIC MISCONDUCT?

A survey (Martinson et al., 2005) of 3247 US, NIH-funded scientists, reported that 15.5% changed the design, methods, or results of a study in response to pressure from a funding source; 10% withheld details of methods or results in papers or proposals. Furthermore, the US Office of Research Integrity has, on average, only 24 cases of misconduct presented to it annually, but in a direct survey of NIH-funded scientists, within the limitations of the study, it was calculated that scientists observed, as an absolute minimum, 2325 incidents per year (Titus et al., 2008).
Surprisingly, there are virtually no data for dentistry, but a survey undertaken by the American Association for Dental Research (Bebeau and Davis, 1996) found that falsification of data had been observed by 30% of the 76 (out of 98) program chairs/Association officers responding, and 54% reported having observed plagiarism at least once.

**SCIENTIFIC MISCONDUCT AND ITS EFFECTS**

Many kinds of misconduct exist, but two examples demonstrate the seriousness of the issue and how clinical practice can be affected, even before alleged misconduct is confirmed.

The case of Jan Hendrik Schön illustrates fraud even at the most prestigious and most scrutinized levels. This German physicist was a rising star in the field of nanotechnology, but the scandal that broke around Schön shocked the scientific world and raised many questions regarding the safeguards upon which we rely so much. His papers, repeatedly published in the journals *Nature* and *Science*, passed the peer review process. It was only following multiple publications that sharp-eyed researchers at other institutions, trying to repeat his results, spotted a peculiar similarity in background ‘noise’ in some of the graphs— inexplicable unless the same data were being used over again (BBC Web site 1, 2004).

In 2002, Bell Laboratories, Schön’s employers, appointed a committee to investigate possible scientific fraud (Beasley report, 2002). It found that Schön had kept no laboratory notebooks, and the raw data had been erased from his hard drive— Schön claiming that he was short of disc space. His experimental samples had been discarded or damaged beyond repair, and virtually no one else had witnessed what he himself claimed to have witnessed.

The report found evidence of Schön’s scientific misconduct in at least 16 of the misconduct allegations. Schön alone was found responsible for the misconduct, and although his co-authors were exonerated, it was unclear whether all of them had exercised sufficient professional responsibility in trusting (and not questioning) the integrity of his data (Beasley report, 2002).

The second case shows how even allegations of scientific misconduct (here, combined with poor research methods; Greenhalgh, 2004) may directly affect clinical practice. In 1998, *The Lancet* guidelines stated, ‘The conflict of interest test is a simple one. Is there anything . . . that would embarrass you if it were to emerge after publication and you had not declared it?’ (Horton, 2004a).

In 1998, Dr. Andrew Wakefield published a paper in *The Lancet*: ‘Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children’ (Wakefield et al., 1998). Few would predict the repercussions that followed, but it triggered a huge controversy over the MMR (measles, mumps, rubella) vaccine in the UK and Europe. The authors raised the possibility of a link, based on parental and medical histories, that autism was likely to be linked with the vaccination of children receiving the MMR vaccine, and suggested that “further investigations are needed to examine this syndrome and its possible relation to this vaccine” (Horton, 2004b). This interpretation, together with a suggestion made by Wakefield during a separate press conference (that there was a case for splitting the MMR vaccine into its component parts), triggered a collapse in confidence in the UK’s MMR vaccination program (Horton, 2004b) as well as elsewhere in Europe. The issue was picked up by the media, and many panicked parents rallied behind Dr. Wakefield.

In 2004, an investigation by *The Sunday Times* newspaper sparked a partial retraction by ten of the study’s co-authors. The interpretation (that a connection existed between the vaccine and the new syndrome) was retracted (Horton, 2004b).

So: What were the issues? In February, 2004, serious allegations of research misconduct concerning the Wakefield article were brought to the attention of senior editorial staff of *The Lancet* (Horton, 2004a). The allegations included problems associated with:

- the ethical approval;
- the selection process; and
- conflicts of interest, including financial.

The children who were reported in *The Lancet* study were also part of a Legal Aid Board (LAB)-funded pilot project, led by Dr. Wakefield, from whom he received £55,000 to conduct the pilot.

Between 2006 and 2010, Dr. Wakefield was involved in a hearing with the General Medical Council. The GMC Web site noted (GMC Press Office, 2009) several allegations, including the following:

“Panel will also inquire into allegations that Dr. Wakefield was involved in advising solicitors acting for persons alleged to have suffered harm by the administration of the MMR vaccine.”

“‘It is alleged that:

Dr. Wakefield’s conduct in relation to research funds obtained from the Legal Aid Board (‘LAB’) was dishonest and misleading. ‘Dr. Wakefield ought to have disclosed his funding from the LAB to the Ethics Committee but did not.

‘The Panel will inquire into:

‘• allegations that Dr. Wakefield ordered investigations on some children as part of the research carried out at the Royal Free Hospital from 1996–98 without the requisite pediatric qualifications to do so and in contravention of his Honorary Consultant appointment.

‘• allegations that Dr. Wakefield failed to disclose his involvement in the MMR litigation, his receipt of funding from the LAB and his involvement in a Patent relating to a new vaccine to the Editor of *The Lancet* which was contrary to his duties as a senior author of the *Lancet* paper.”

He denied the charges (BBC Web site 2, 2007), but the GMC has now ruled that he acted unethically in performing his research and have in fact determined that Dr Wakefield’s name should be erased from the medical register. *The Lancet* has now also retracted the 1998 paper (Fiore, 2010).

In the meantime, Health Protection Agency figures demonstrate sharp increases in the number of measles cases and falls in vaccination rates occurring in England (1998: 56 cases of measles in England; by 2008, 1370 cases; Health Protection Agency Web site 1, 2010). Prior to 2006, the last death from
acute measles was in 1992 (Health Protection Agency website 2, 2010). Furthermore, the vaccine uptake is below the 95% level recommended by the World Health Organization to prevent outbreaks of disease. In 2007/08, only about 85% of British children had been immunized against measles, mumps, and rubella with the MMR vaccine (BBC Web site 3, 2009). It has been suggested that there is a direct link with the Wakefield paper (BBC Web site 2, 2007). The likelihood that measles will be a disease of the past in 2010 is now diminishing (BBC Web site 3, 2009).

WHAT ABOUT DENTISTRY?

Only the case of Jon Sudbø appears to have hit the headlines. A doubly qualified Norwegian doctor and dentist, he fabricated data for over 900 subjects (Marris, 2006; Gren, 2007). The “study” reported on the effects of certain painkillers on oral cancer risk in smokers. An inquiry found that most of his 30-odd publications were invalid because of fabrication and manipulation of data. Sudbø resigned the day after the commission released its report (Odling-Smee et al., 2007).

However, based on previous reports (Martinson et al., 2005; Fanelli, 2009) and the 300% increase in the numbers of dentists being investigated for serious professional misconduct (2004–2007) in the UK (Singh et al., 2009), it seems complacent to assume that the dental community is immune.

As engagingly reported in The New York Times, “It may look authentic; here’s how to tell it isn’t” (Wade, 2006), when images started to be submitted digitally, the editors of the Journal of Cell Biology noticed image manipulation occurring. In fact, 25% of authors had violated their guidelines, and of those, 1% had engaged in fraud.

New guidelines were introduced and tests developed to assess images in an attempt to prevent faking—which brings us to the potential for image manipulation in dentistry. It takes little imagination to see how such digital image manipulation software can easily be applied to basic science research, but, in these times of so-called “aesthetic dentistry”, also to case reports, dental product manufacturer advertising, etc. Are we happy just accepting at face value what we are shown?

“DIGITAL FORENSICS”

Techniques are now being developed to detect covert image-tampering. Indeed, there is now effectively a new science: that of “digital (image) forensics” (Farid, 2009). The following is only a very brief summary of this work.

Pixel-based

Tampering commonly uses a cloning tool to cut and paste sections of an image to obliterate unwanted details. This may be invisible to the naked eye, but mathematical algorithms can detect pixel blocks that have similar spatial offsets (and which would thus be unusual in an image where variation would be the norm).

Composite images often require resizing and other distortions to make a convincing, contemporaneous-looking image. However, because the image may be placed on a new pixel lattice, this introduces new, periodic specific correlations between neighboring pixels which change the original’s statistics. Again, the fact that these would not occur naturally means that they can be detected mathematically.

Format-based

Images are compressed into JPEGs according to a series of steps, but flexibility exists within this process. Camera manufacturers may therefore configure their own devices according to their own preferred balance of compression vs. image quality. Farid (2009) likens this to the use of ballistics in weaponry; effectively, there is a “fingerprint” that can be attributed to a piece of hardware. Other statistical variations also occur, e.g., when images are manipulated and recompressed when saved. Analyses can detect variations in the distribution of pixel blocks—for example, from a random to a more structured layout.

Camera-based

When photographs are taken, light is subjected to various artificial distortions while traveling through lenses. Chromatic aberration varies (at least to an extent) according to the camera used. Shifts in spatial distribution occur when lateral aberration results in light of different wavelengths being split up, thus hitting the sensor in different positions. This produces a specific array that can be approximated as an expansion or contraction of the color channels with respect to one another. If another image is then added to the original, its array is different, so this discrepancy can again be detected.

Physics-based

Various techniques can be used, but assessing the consistency of light fall or direction is one means of investigating tampering. A simple example could involve analysis of the consistency of shadowing across a surface (such as a face) and/or light reflected from eyes.

Geometry-based

When a photograph is taken, the principal point can be calculated—the projection of the camera center onto the image plane. If another image is superimposed, this moves the principal point proportionally. The difference between estimated and actual positions can provide evidence of tampering.

WHERE DO WE GO FROM HERE?

Evidently, scientific misconduct should concern the whole clinical/scientific community. Patient care is at risk. However, we should not be fooled into thinking that scientific misconduct is a concern only when on the grand scale, and that anything less than headline-grabbing can simply be passed off as “sloppy research” (Kansu and Ruacan, 2002) or ignored. Steps can be taken to help prevent misconduct—but this may require new systems and, above all, education, awareness, and enforcement.

For example:

- The problem of token authors can be influenced if journals use contributor statements, defining what constitutes
“authorship”: the roles, responsibilities, and level of contribution that has to be achieved to meet the requirements of being an “author”.

- Editors could request to see all authors’ recent/related papers published and/or under consideration, to reduce problems associated with authors publishing the same or similar data in different papers, or “salami slicing” (No Authors Listed, 2005)—cutting bigger works into smaller ones. This practice can simply enhance someone’s status, but at the same time, distort the true, full picture of the work.

- Software exists to help detect plagiarism and could be used by journals. Even pasting a passage into a search engine may be sufficient to detect plagiarism.

- Software will likely become available to help detect image fakery, as already discussed.

- Journals could introduce image manipulation limits to which authors confirm that they have adhered.

- Heightened awareness of other ‘game-playing’ (e.g., manipulation of clinically relevant differences in sample size calculations to make research easier to perform) may help editors/reviewers to spot such goings-on and reject inappropriately submitted research papers, avoiding publication of misleading results.

- Co-authors need to know that they have a major role: Peer review is most unlikely to be able to detect fraudulent data—but co-authors might. They can also help ensure that study methods are presented honestly, e.g., ensuring that retrospective data are clearly noted as such, and that such data are not passed off as prospective.

- Funders and institutions gain from avoiding damaging claims of fraud and ethical breaches. Therefore, to encourage an ethos of prevention, institutions could ensure that they have processes which are transparent, unbiased, and allow for open investigation (see UKRIO, 2009, for example). Processes should not unduly protect their most successful grant applicants or ignore/deny such issues.

- Professional societies could issue and publicize guidance to their members, while their members should alert journal editors to fraud if they see it.

Ultimately, however, as noted by Marcus (Wade, 2006), these matters are everyone’s responsibility; journals alone cannot stamp out scientific misconduct. Evidence-based clinical/research training should demand that everyone know the professional etiquette of good and bad practice so we may all see bad practice for what it is. That way, we have more chance of protecting patients and ourselves and advancing science—rather than assisting dishonest individuals who rate their status as more important than anyone else’s.

REFERENCES