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An Assessment of Retractions as a Measure of Scientific Misconduct and Impact on Public Health Risks

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An Assessment of Retractions as a Measure of Scientific Misconduct and Impact on Public Health Risks

by

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A dissertation submitted in partial fulfilment
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DEDICATION

This work is dedicated to my family, friends, and academic peers and leaders. I am grateful for your continuous support and faith - even during my most egregious hermit phases.

But unabashedly most of all, this is dedicated to Jordanna and Christina.

D and T, you are my heart, my spirit, my conscience, my pride.

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My name may be the only author on this dissertation, but in no way can this dissertation be considered the work of one person. Several people contributed in ways well beyond simple authorship, directly and indirectly.

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ABSTRACT

Research misconduct has been generally considered a limited issue, occurring in a small percentage of research studies. Studies of the number of article retractions use retraction percentages to perpetuate the idea that research misconduct is not a common event, and use information in the retraction notice to quantify types of research misconduct and types or research error. However, retractions appear to be the wrong variable with which to assess misconduct rates and characteristics. Using final misconduct findings in hard science research from the Office of Research Integrity (ORI) for investigations closed from 1993 through 2013, the number of publications and subsequent retractions or corrections per final ORI finding was analyzed. Out of 167 subjects who received ORI sanctions, 84 (50.3%) had no publications associated with their misconduct. Of the remaining 83 subjects, only 72 had at least one retraction associated with their misconduct, i.e., only 43.1% of the all study subjects sanctioned for misconduct had at least one retraction from misconduct. Of the 231 retractions and corrections arising from the sanctioned misconduct, only 94 notices (40.7%) gave research misconduct as a cause for the retraction or correction. Thus, the study demonstrates that research misconduct occurs at a greater rate than retractions for misconduct are published, and retraction and correction notices cannot be relied upon to convey the presence of fraudulent data within the publication.

CHAPTER ONE:

INTRODUCTION

1.1 Prevalence of Research Misconduct

In the past, scientists considered the incidence of research misconduct as a rare event (Fanelli, 2009; Baerlocher et al., 2010). A consensus of 40 United Kingdom researchers, in forming a priority list of research misconduct behaviors, decided that "(a)lthough there has been considerable attention in the scientific literature on the problems of data fabrication and data falsification these were absent from our list of the most important forms of misconduct because there was majority agreement that these problems were very unlikely to occur." (Al-Marzouki, Roberts, et al., 2005). The prevailing view was that the rarity of research misconduct had little negative effect on the science literature at large. (Al-Marzouki et al, 2005; Fanelli, 2009; Baerlocher et al, 2010). Extensive media coverage for high-profile misconduct investigations encompassing multiple retractions and large sums of grant monies are fast and fleeting, and may actually increase the perception of research misconduct as serious but sporadic occurrence. (Zhang and Grienseison, 2013).

The conflicting attitudes within the research community concerning the nature and degree of misconduct complicated studies of research misconduct. A (very) informal seminar survey of doctoral and postdoctoral students found barely half of them considered data farming (i.e, selecting or deleting data to ensure a desired result) an offense worthy of censure (Cole, 2014). On the other side, a survey of scientists and institutional researchers by Korenman et al, (1998) indicated that

they considered behaviors as unethical if the behaviors were characterized as misconduct. Baerlocher et al. (2010) surveyed 127 research authors who published in at least one of four highly-respected research journals. Only five authors (4%) stated that they had discovered fraudulent data in a project. Oddly, 15 authors (6.7%) stated knowing the manuscript containing fraudulent data from the project had been published. Baerlocher et al. suggested that a misunderstanding over the phrasing may have been responsible for the inconsistency, or that some of the authors "did not initially wish to admit" to knowing of fraudulent data. Nonetheless, discrepancies like these shows the difficulty in establishing the true extent of misconduct found within research projects.

More recent discussions with research investigators and active researchers suggest that the incidences of misconduct are far greater than previously thought. David Wright, Director of the Office of Research Integrity (ORI) from 2012-2014, ventured in an interview with EMBO editor Holger Breithaupt that scientific misconduct is underreported and is closer to 3% of all funded research (Wright and Breithaupt, 2012). Titus et al. (2008) suggested that the incidence rate of misconduct may approach 3 in 100 researchers, based on an ORI-initiated Gallop study of NIH-funded researchers (Wells, 2008). The study forms provided the poll participants the federal definition of misconduct: "fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results" (OSTP, 2000).

Titus et al. further pointed out a curious finding; although the federal definition of misconduct was provided in the survey, the NIH-funded researchers characterized some behaviors they had witnessed as misconduct, despite a lack of coherence with the federal definition. They proposed that this anomaly suggested the federal definition is too narrow; what is unknown is if a narrow definition of misconduct implies an illicit encouragement of a wider range of questionable research practices. Gino and Bazerman (2009) examined the propensity of study subjects to find

unethical behavior acceptable if the behavior develops over time rather than appearing suddenly. They referred to the phenomenon as "erosion" of ethical standards. They also suggested that in such situations, people cease to even notice the unethical behaviors. Should this effect be true, determination of rate of research misconduct by conducting any survey or study of observers reporting misconduct events would likely be an underestimation of research misconduct incidence.

1.2 Retraction Studies Enter the Picture

In the 1990's, retractions studies grew in response to the increasing awareness of research misconduct. The retraction studies tended to downplay ; the small percentage of retractions compared to the increasing number of articles portrayed the misconduct problem as negligible even while some statistical analyses suggested that retractions should be occurring in greater quantities (Cokel et al., 2007)

However, these initial studies of retractions were very limited by a lack of information contained in the retraction and correction notices (Pfeifer and Snodgrass, 1990); many journals were still only in print form. Nonetheless, tracking retractions flourished in studies of research and publishing misconduct, and soon became synonymous with studies of scientific misconduct. Soon the incidence of retractions became perceived as the quantification of misconduct.

Retraction studies generally followed a standard methodology. A database was chosen, (generally Pubmed or MEDLINE), keywords such as "retracted publication" and/or "retraction" were used for the database search, and the retractions found were then categorized for fraud, error, plagiarism, or non-reproducibility, based on the information provided in the notice. Some studies modify the categories for more specificity. Journal impact factor, country of author(s) origin,

number of authors, and author placement in the author list were generally included in the dataset; different studies modified or expanded the dataset categories.

1.3 Attempts to Characterize Misconduct

Various traits were studied of the authors of retracted articles, and were generally limited to the information provided in the article and any retraction or correction notice, or with notices occurring from some assigned cause. Some studies associated the sanction author's placement in the author list; Wooley et al (2011) and Stretton et al. (2012) proposed an association between first authors, low-income countries, and retractions for misconduct. A common theme among studies proposed that journals with higher impact factors (e.g., greater than 10) are targeted by fraudulent researchers (Grieneisen and Zhang, 2012; Fang et al, 2013). Fraudulent articles authored by junior researchers were retracted sooner than those of senior researchers ((Trikalinos et al., 2008.), but no difference was apparent between research fields. Retraction studies adopt and discard associations depending on how much information they gather beyond that of the retraction notice. After originally assigning the majority cause of retractions to error in earlier works, Fang et al (2012) attributed misconduct as the majority cause when additional research allowed the reclassification of a number of retractions.

Researchers of retractions are also as likely to remain bound to prior associations, despite evidence to the contrary. Steen and Hammer (2014) noted that anesthesiology had a disproportionate number of retractions in their dataset and "strongly" disagreed with the Trikalinos et al. (2008) finding of no associations with misconduct retractions and field of study. Steen and Hammer posited that "anesthesiology is the field most prone to retraction", but followed up by stating "Still, without Reuben, anesthesiology would not be more corrupted by misconduct

than any other medical field." What merits notice is that "Reuben" referred to Scott Reuben, an anesthesiologist who was responsible for 63.6% of the retractions, a calculation made in that same study by Steen and Hammer.

1.4 Problems with Retraction Studies

While studies on retractions may provide valuable information on publishing tendencies, they are less likely to allow for the characterization of misconduct. For example, one study used PUBMED as the database to locate retractions, using the filter "items with abstracts, retracted publication, English", then stated that the study showed "unequivocally that scientists in the USA are responsible for more retracted papers than any other country" (Steen, 2010). While Pubmed is a remarkable source of literature with an expansive database, limiting the language to English would be likely to skew the findings away from non-English speaking countries who fail to produce adequate translations. Assuming then, one wished to draw conclusions only about countries with English as a primary language. In that case, no association can be fairly made about country of origin; one can assert either that associating with an English-based culture increases the likelihood of fraudulent behavior, or that English-based cultures are more vigilant in purging questionable studies.

1.4.1 "Would I Lie to You?"

A significant problem in these studies of retractions appears to be rooted in the general belief that the printed word is somehow inherently accurate. For example, Decullier et al. (2013), in their study of retractions and conformity to COPE (Committee on Publication Ethics) guidelines, provided percentages per country for the "most cited reasons". Yet in their discussion

they state that the "most frequent reasons for retractions in 2008 were mistakes (28%), followed by plagiarism (20%) and fraud (14%)". Unfortunately it would be easy for readers to assume that somewhere in the study Decullier et al. had confirmed the retraction statement, which they hadn't.

A study by Budd et al (1999) regarding citations of retracted articles displayed a bit of naiveté in their stated assumption: "authors are assumed to be the ones doing the retracting, because they would be in the position to be aware of errors or misconduct." In another study, Budd et al (1998) appeared reticent to label retractions as misconduct, choosing to do so "only if the statement of retraction clearly admits to wrongdoing on the part of one or more authors".

Fang et al (2012) checked further into the circumstances leading to retraction notices attributed to error and reclassified roughly 16% of them as misconduct.

1.4.2 Is the Dataset Complete?

A 1980's investigation of 135 articles by a researcher suspected of misconduct resulted in 60 articles being deemed fraudulent or at least suspicious in quality; only 18 were retracted. (Couzin and Unger, 2006). An 8 year investigation into Friedheld Herrman, a German oncologist, ended with only 13 of his 29 fraudulent papers retracted, six of 56 suspicious papers retracted and two corrections (Ibid.). Two articles escaped retraction (as required by the ORI sanction) for 17 years (Oransky, 2012). Retractions do not occur for every case of misconduct. Even when they do, they may not be timely or in proportion to the misconduct.

Determining whether a retraction is from misconduct is aggravated by variances in the phraseology used for each notice. Studies of retraction and their relation to misconduct often use terms as "falsification" or "fabrication", misconduct, or unethical to identify the retraction as being a consequence of research misconduct (Resnick and Dinse, 2013) Others avoid any reference to

misconduct and assign cause to error or irreproducibility (Redman et al, 2008). Still others uses phraseology so obscure that it is virtually impossible to accurately assign a cause (Wager and Williams, 2011).

1.5 A Genuine Cause for Concern

Highly publicized cases of fraudulent research allow for some quantification of iatrogenic injury to patients. However, most cases of misconduct are not publicized and rarely are subjected to downstream scrutiny of potential and actual harm sustained by recipients of treatments based on fraudulent research. Even when the misconduct is identified before reaching manuscript phase, the progress in clinical trials can be thwarted by necessary efforts to unmask and repair fraudulent work. One misconduct case stalled a clinical trial for two years while the records were purged of fraudulent data and reorganized. (Redman, 2006.) Worse yet, once fraudulent research results in a publication, it can remain unretracted for years after the misconduct is detected (Trikalinos et al., 2008), allowing researchers to pursue invalid or even potentially harmful science.

Once misconduct reaches the publication phase, the risks to public health increase exponentially as access to fraudulent research increases. Open access publishing, an excellent means of conveying sound research methodologies and theories to a greater audience, also subject the same audience to unsound research. A study of research articles published in open-access journals in 2003 found that over one-third of the articles could be located on non-journal websites (Wren, 2003). The risks of the perpetuation of fraudulent research then increase, and non-journal websites are unlikely to receive notice of an article's subsequent retraction or correction, whatever the underlying cause.

Even journal websites and publication databases offer limited protection from the prolongation of faulty research. Budd et al, (1999) checked citations of articles retracted during 1966-1996 and found 2,034 post-retraction citations. They found most citations appearing in the Introduction and Discussion sections and thus were most likely only used to bolster (however incorrectly) the research theories described in the article. Unfortunately, 154 citations were in the Methods section and are therefore thus quite likely to continue bad science performance. Improvements in technology and online access to journals hasn't appeared to improve notification of fraudulent research. Recent studies by Davis (2012) and Fang et al. (2012) show retracted articles continue to be cited without regard to their retraction status. As long as fraudulent research practices continue undiscovered, the likelihood of it permeating through the literature remains ever-present.

1.6 Hypothesis

In the late-80's under the auspices of the Health Research Extension Act, the Office of Scientific Integrity and Office of Scientific Integrity Review were created. These offices were soon merged in to the single Office of Research Integrity (ORI). The ORI is the primary office under the Secretary of Health and Human Services with oversight over research and funding by the Public Health Service (PHS) and the National Institutes of Health (NIH); the ORI does not have direct oversight over the FDA, as it handles its own issues. In keeping with its legislated function, the ORI investigates allegations of misconduct in research receiving NIH and PHS funding, and issues determinations of misconduct or closures with no misconduct findings. The ORI generally works in concert with the institution having oversight over the suspected fraudulent research, but

in cases where the institution lack suitable investigatory measures, the ORI may assume the primary role as investigator.

Once an investigation is closed, the ORI publishes a case finding. In cases where the scientific or research misconduct may have affected the results in a published article, the ORI may (as part of a civil agreement with the Subject of the investigation) require retraction or correction of the affected article(s).

The ORI reports are more likely to provide better substantiation of misconduct related to the publication of articles than that of a retraction notice, especially since no standardization of form exists for retraction and correction notices (Davis, 2012). Using general databases such as Pubmed or Medline provides no assurance that non-retracted articles are free from fraud; retraction and correction tallies have no guarantee of being complete or comprehensive. Using the ORI misconduct findings, this study will explore the hypothesis that retractions do not accurately represent the incidence and prevalence of research misconduct in the biomedical, health and life sciences.

CHAPTER TWO:

METHODS

2.1 Defining Terms and Categories

The data for this study were chosen from ORI misconduct findings for scientific or research misconduct from 1993 to 2013. To be considered "Hard" science, some type of analytical (objective) research method must have been the foundation for the study, such as chemical analyses or radiographic imaging. "Soft" sciences were considered research methods involving study subject recall or judgement, or any type of subjective measurement system. Determination was made by the information provided in the ORI finding or by review of the referenced research in the finding, rather than simply categorizing by general topic area such as chemistry or anthropology. For example, although social sciences may be generally considered a "soft science", a study of blood chemistry levels of cortisol after witnessing an event involving serious bodily injury or death of another would be considered "Hard" science, provided the research misconduct had to do with the blood analysis and not the interview of the Subject to determine the Subject's perceived level of stress. On the other hand, a study of cancer patients' perceived quality of life while undergoing different chemotherapies would be considered "soft" science, provided the research misconduct occurred in the surveys of patients and not in the manipulation of chemotherapy drug protocols.

Differentiation was made concerning the concept of "research" misconduct as well. As the impetus for this study came from a rousing discussion of retractions due to fraudulent research in

laboratories, the entire research publishing process was divided into three areas: administrative, research, and publishing. Administrative misconduct was defined to involve issues dealing primarily with paperwork, e.g., consent forms, Institutional Review Board forms, etc. Inappropriate patient eligibility findings were also included in the category of "administrative misconduct" if the Subject was not involved in the actual analytical testing of the patients, as in the case of Barbara Jones, a data coordinator at St. Mary's Hospital in Montreal, Quebec who falsified tests for eligibility forms for two women in a breast cancer study (ORI, 1996). Final ORI misconduct findings involving only administrative misconduct were not included in the dataset.

Misconduct events were categorized as "publishing" misconduct for instances involving only the production and publication of the manuscript arising from the research in question. Examples are plagiarism of text in published articles or when author names are added or removed by the Subject for their own purposes, regardless of the author's contributions or lack thereof. Attempts to thwart the peer-review process, as in the case of the authors of the 60 retractions from the Journal of Vibration and Control (Baker, 2014), were also including under the category of "publishing. Those who plagiarized but did not manipulate data were also considered under "publishing", but those who plagiarized data and then manipulated it to fit their own research findings were considered under "research" misconduct. Final ORI misconduct findings involving only publishing misconduct were not included in the dataset.

Misconduct events categorized as "research" misconduct were those with fabricated or falsified analytical or imaging test results. Intentional modification of standard test protocols (e.g., changing or spiking reagents to ensure a set of desired results, changing instrument settings), sabotage of research of one's own or others were also included under "research" misconduct. Figure 2.1 shows the decision flowchart for the selection process.

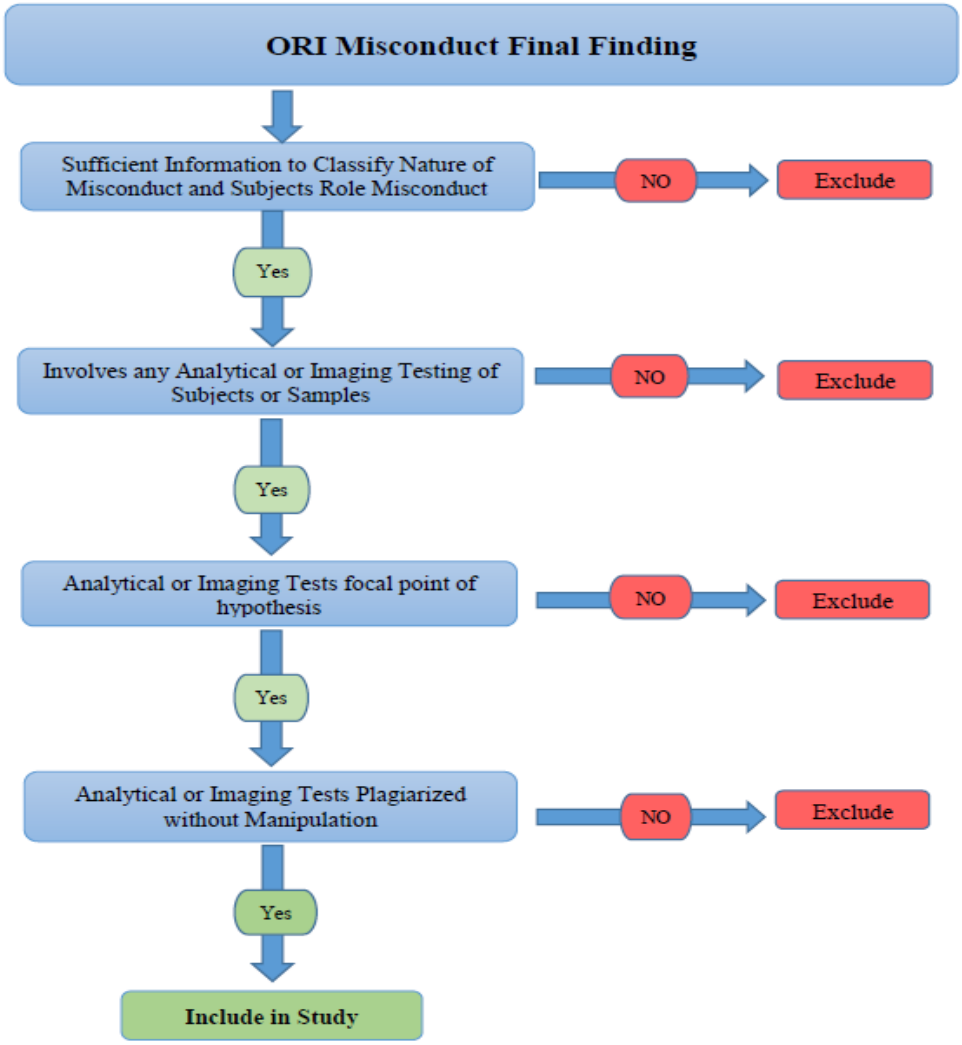

Figure 2.1 Flow Chart of Decision Process for Subject Selection

Review of the information provided by the ORI misconduct findings did not always provide clear boundaries for categorization. While some findings were quite detailed, some findings were so brief that considerable effort was required to ascertain some semblance of understanding of the circumstances for categorization of hard research misconduct (HRM).

Typically, the earlier findings were quite brief, while the later findings were more detailed – but that was not always the case.

Final ORI misconduct finding for each Subject generally included the Subject's position at the institution managing the NIH/PHS grants for the research, the sanctions bestowed and the number of years for which the sanctions apply. Due to a lack of standardization among institutions in positional responsibilities and job duties per position title, the position titles were grouped into general position categories (Table 2.1).

Table 2.1 Position Categories and Associated Titles

Position Category	Position Title by ORI or Secondary Source
Assistant or Associate Professor	assistant professor associate professor former assistant professor former associate professor former faculty member former instructor former research assistant professor former research professor research assistant professor adjunct assistant professor
Director or Department Chair	clinic coordinator department chair director of the laboratory clinic coordinator
Doctoral Student	former visiting fellow former doctoral candidate former doctoral fellow former doctoral student doctoral student
Graduate student	former graduate student graduate student former master's degree student
Medical Resident or Student	medical student former MD/PhD student former Surgical Resident neurosurgical resident House Officer

Table 2.1 (Continued)

Position Category	Position Title by ORI or Secondary Source
Postdoctoral	former postdoctoral scholar, student or fellow former postdoctorate student or fellow former postdoctoral research trainee postdoctoral associate postdoctoral fellow former postdoctoral researcher former postdoctoral research associate postdoctoral student
Primary researcher	primary researcher former senior scientist former scientist former senior investigator principal investigator
Professor	former Professor Professor
Research Associate	research associate research fellow former research fellow former research assistant former research project coordinator former clinical research associate former research scientist former research coordinator former staff biochemist former research associate
Technician	technician data coordinator former technician phlebotomist former research technician staff assistant undergraduate student former laboratory technician

For the purposes of this study, an "article" was any published piece for which there was an author listed. Typically, conference abstracts were not considered as "articles" unless they were published for public access. In other words, abstracts published in a limited access conference volume were not considered as an "article", while an abstract published in a journal special edition

(which would have correction or retraction notices) were considered an "article" for purposes of retraction or correction.

Again for the purposes of this study, a "retraction" was the removal, withdrawal or retraction of the entire article from the publishing journal. Partial retractions, where only figures and/or paragraphs were designated for removal, were counted as corrections. Corrections were thus considered any change to an article without the withdrawal of the entire article.

Those retractions and corrections where falsification or fabrication was indicated as a cause, using terms such as "not authentic to original data", or including a reference to an ORI or other institutional investigation were indicated as "HRM", meaning "Hard" research misconduct. Retractions and corrections using terms such as "erroneous", "not valid", or "not accurate" were labeled as "Error". Those retraction or correction notices describing study results as "not reliable", "unable to reproduce findings", or similar terms were labeled as "NR" (for "not reproducible). Thus, a retraction notice (RN) where the reason for the retraction is given as "results could not be replicated" would be indicated in the study's dataset as "RN NR". Similarly, a correction notice (CN) for replacement of a table due to "inaccurate data" would be indicated as "CN error" in the study's dataset. When no reason was given for the retraction or correction, or the article was marked as retracted but no notice could be located, or when no hard copy was available and the notice of retraction or correction was only found through database references, the acronym "NFI" (no further information) was used. In the case of corrections for partial retractions, the notation "p/r" was added.

Table 2.2 provides an example of keywords used to categorize the Retraction and Correction notices. A Notice of Concern (NOC) was noted as such in the dataset, but was counted under correction notices, following the same keyword categorization. When a retraction notice

followed a correction notice for the same article, only the retraction notice was counted. When a correction notice followed an NOC, only the correction notice was counted; for retractions following a correction following a notice of concern, only the retraction notice was counted.

Table 2.2 Keywords for Categorizing Retractions and Correction Notice

Category	Sample Words in Retraction or Correction Notice
HRM	"not authentic", "falsified", "fabricated", "misconduct", under investigation", "suspicious"
Error	"not valid", "error", "not accurate"
NR	"unable to replicate", "not reliable", "cannot reproduce", "non-reproducible"
p/r	"partial retraction", "only (insert phrase) is/are withdrawn/retracted/removed"

2.2 Database Development

The datasets for this study were built from final ORI misconduct findings from 1993 through 2013. The final ORI misconduct findings were taken from review of ORI newsletters, annual reports and case studies, obtained through the ORI website http://ori.hhs.gov/. Only Subjects with a standing final ORI misconduct finding were included in the dataset; Subjects whose findings were later overturned were not included. Subjects who received a final ORI misconduct finding in the area of "hard" research misconduct (HRM) were differentiated from those who were found to have committed misconduct in "soft" research misconduct (SRM); only Subjects with HRM findings were included in the dataset. In cases where the final ORI misconduct finding did not contain sufficient information as to the research area, other sources of information were sought (e.g., ORI website, Institutional press releases, court documents, etc.). If no determination as to the research area could be made after checking other sources, then the Subject was excluded from the database.

Only Subjects whose final ORI misconduct finding met the criteria for research misconduct were included in the dataset. Subjects whose final ORI misconduct finding were in research

misconduct as well as in administrative and/or publishing misconduct were also included in the dataset. In cases where the final ORI misconduct finding did not contain sufficient information as to the type of misconduct, other sources were sought to determine the nature of the misconduct (e.g., ORI website, Institutional press releases, court documents, etc.). If no determination could be made after checking external sources, then the Subject was excluded from the database.

For each Subject included in the dataset, the Subject's position, the institution, the sanction and sanction time period was recorded. When no position title was provided in the finding, or if the term "employee" was used, internet sources by way of court documents, institutional press releases or newspaper accounts were used to identify the position held by the Subject at the time of the misconduct. Only the "most advanced" position title was used in any assessments, i.e., if a Subject's positions were listed as graduate student, doctoral student, and postdoctoral student, the position assigned to the Subject would be as a postdoctoral student.

Each misconduct finding was reviewed for any reference to the publishing of any article associated with the research in which misconduct was found. A count was made of the number of published articles listed within the final ORI misconduct finding, as well as the respective journal name(s). Each article referenced in a final ORI misconduct finding was checked for retraction or correction status by use of the following databases: MEDLINE, PUBMED, Google Scholar, and the individual journal electronic database. Notices of retraction, correction and/or concern were tallied per journal and Subject. If an article was marked or stamped as "retracted" or a comment of "retracted" or "retraction" was made on a database, but no notice of retraction could be located, the article was still coded as retracted, but tagged as NFI. Each retraction and correction notice was assigned according to the reason, or lack thereof, in the notice.

For each Subject with a final ORI HRM misconduct finding, a database check of retracted and corrected articles with the Subject listed as (co)author was made. Retracted and corrected articles not described or listed within the final ORI misconduct finding would be examined for retraction of correction cause. Those articles that had a retraction, correction or Notice of Concern referencing the ORI investigation as the cause of the notice would be included in the dataset as part of the Subject's total article count. Articles retracted or corrected that did not reference the Subject's final ORI misconduct finding were examined for content and timing. If the article affiliated with the notice concerned research in the same subject matter and timeframe as the research referenced in the misconduct finding, the article was included in the dataset as part of the Subject's total article count. The journal in which the included article was published was also included in the dataset.

The 2013 five-year impact factor for each journal in which a dataset article was published was determined from the Journal Citation Reports® (JCR®). Because the ORI investigations included published articles spanning over four decades, the choice of the 5-year impact factor seemed the most stable indicator for use.

2.3 Statistical Analyses

The datasets were built using Excel 2013 spreadsheets. Excel 2013 was also used to format graphs and calculate the Pearson Correlation Coefficient. SPSS version 2.1 was used for ANOVA analyses.

CHAPTER THREE:

RESULTS

3.1 General Demographics

Of the 239 persons named in final ORI misconduct findings, 167 Subjects were included in the dataset for analyses of Hard research misconduct (Table 3.1). The remaining Subjects (Table 3.2) were eliminated for the misconduct having occurred in "Soft" science (n = 48) or having occurred in "Hard" science but only in administration or publishing areas (n = 19).

Table 3.1 ORI Subjects included in HRM Dataset

Abbs, James H	Eagan, George E	Horvath, Emily M	London, Jill A
Afshar, Nima	Eierman, David F	Huang, Chang-Fen	Lorenzo, Nicholas Y
Altman, Robert J	Elton, Terry S	Jacoby, David R	Lowe, Patrina
Angelides, Kimon J	Fogel, Robert B	Jiao, Shoushu	Ma, Jian
Apte, Aaron	Fossel, Eric T	Jin, Wei	Manojlovic, Marija
Arichi, Tatsumi	Francis, Peter J	Jorge-Rivera, Juan Carlos	Marcus, Rebecca
Arnold, Steven F	French, Randall P	Kammer, Gary M	Matsuguchi, Tetsuya
Aronica, Susan	Friedman, Andrew	Karunakaran, Thonthi	Mayack, Shane
Bartsch, Lois	Ganz, Michael B	Kerr, Catherine	McMaster, Nicolas
Bednarik, Daniel P	Garey, Caroline E	Kim, Sinae	Miller, Michael W
Bhrigu, Vipul	Gelband, Craig H	King, Cynthia	Misra, Manoj
Bois, Philippe	Glennon, Eileen	Koltover, Ilya	Monte, Scott E
Boisse-Duplan, Martin	Goodwill, Meleik	Kornak, Paul H	Morrow, Aaron J
Boone, James B Jr	Goodwin, Elizabeth	Kumar, Vipin	Muchowski, Paul J
Briggs-Brown, Nellie	Grol, Jessica Lee	Kurtzman, James T	Muenchen, Heather J
Brodie, Scott J	Gu, Peili	Langlois, Paul F	Mungekar, Sagar S
Bryant, Joy	Guffee, Judy	Layman, Diana	Munjee, Shaan F
Caruso, Keith A	Hajra, Amitav	Leadon, Steven Anthony	Murillo, Carlos A
Chang, Hung-Shu	Hampton, J Keith	Lee, Cathy Q	Nguyen, Mai
Cheskis, Boris	Handa, Atsushi	Lee, Tian-Shing	Ningaraj, Nagendra S
Constantoulakis, Pantelis	Hanneken, Vickie L	Leonhard, Christopher	Ninnemann, John L
Contreras, Juan Luis R	Harrington, Melissa A	Li, Fugang	Paez, Gerardo L
Coyle, Catherine	Herman, Terence S	Li, Xiaowu	Paparo, Anthony A
Daubert, Gail L	Hiserodt, John C	Liburdy, Robert P	Parachuri, Durga K
Deng, Zhong Bin	Ho, John L	Lilly, Jason W	Park, George A.
Dreyer, Evan B	Hoffmann, Bernd	Lin, James C	Park, Hyuk Jong
Duan, Lingxun	Horvat, Regina D	Lin, Kuie-Fu (Tom)	Paul, Saptarshi

Table 3.1 (Continued)

Pender, Benjamin	Rudick, Charles N	Sotolongo, Jose R	Wang, Sheng
Poehlman, Eric T	Saleh, Ayman	Sperber, Kirk	Washabaugh, Michael W
Poisson, Roger	Sanchez, David D	Stricker, Raphael B	Weiser, Weishu Y
Portuese, Enrico	Sanyak, Shamarendra	Sudbø, Jon	Whitters, Eric
Prabhakaran, Kartik	Sezen, Bengu	Sun, Weidong	Wolfort, Ryan M
Prasad, M Renuka	Shang, Xiaomin	Tanner, Vivian N	Woreta, Hiwot A
Radolf, Justin	Shapiro, David N	Tewari, Anand	Xiong, Momiao
Ramalingam, Tirunelveli	Shelley, Craig T	Thiruchelvam, Mona	Xu, Jianhua (James)
Ramasubban, Sheela	Shin, Junghee	Thomas, Judith M	Yang, Jusan
Ravindranath, Mepur H	Shishov, Michael	Thwaites, Richard	Yao, Zhenhai
Reisine, Terry D	Siddiqui, Farooq A	Tomasula, John J	Yuan, Gang
Robinson, Clifford R	Simmons, William A	Tracy, Robert B	Zhang, Shuang-Qing
Rooney, John W	Smart, Eric J	Urban, James	Zhao, Lingjie
Roovers, Kristin	Smith, Timothy R	Van Parijs, Luk	Zhu, Kui
Roy, Samar N	Solomon, Nicola	Venters, Homer D	

Table 3.2 ORI Subjects not included in the HRM Database

Abdulahi, Yahya	Freisheim, James H	Lieber, James David	Rosales, Oscar R
Arenburg, Deborah	Gans, Joan	Linn, James Gary	Ruggiero, Karen M
Arriaga, Jennifer N	Geisler, Hans E	Lipski, Matthew A	Ryan, Celia
August, Gerald I	Goldring, Amy Beth	Luce, Randall	Santa Cruz, Victoria
Berezniak, Katrina	Gonzalez, Roxana	Lupu, Ruth	Sarker, Malabika
Blackwell, Sheila	Hartzer, Michael K	Lushington, Gerald	Smith, Sherman
Blaisdell, Jennifer	Hauser, Mark	McCown, William G	Strout, Nancy J
Bodily, Janell	Highshaw, Ralph A	Okoro, Sylvia	Sultan, Ali
Chagnon, Mark S	Huelskamp, Ann Marie	Padgett, David A	Surprenant, Annmarie
Clayton, Gloria	Imam, S. Ashraf	Palmer, Pat J	Swe, April
Conrad, Denise R	Ivatt, Raymond J	Pandurangi, Raghoottama S	Tanaka, Kazuhiro
Couvertier, Norma	Jagannathan, Jayant	Paquette, Leo A	Thackeray, Robert J
Creek, Khalilah	Jones, Barbara	Pennington, James C	Valentin, Vilma
deSales, Joao Carlos	June, Harry L	Philpot, Thomas	Vardi, Danya J
Diaz, Maria	Kowalski, Mark M	Qian, Jin	Wanchick, Jennifer
Edberg, Jacqueline	Landay, Alan L	Recknor, Karrie	Weber, Scott
Elster, Jason	Leisman, Gerald	Restrepo, Rocio del Carmen	Woodard, Lajuane
Farooqui, Jamal Z	Li, Yi	Robertson, Rashanda	Zach, Calleen S

The educational status of the 167 Subjects at the time of the finding varied widely, from (presumably) high school education to doctorates. Table 3.3 provides the number of Subjects per general educational title, the mean total retraction and correction notices and the standard deviation of the same. As there were only 1 D.SC.N, 1 DVM and 2 RNs, the D.Sc.N. was grouped with PhDs, the DVM grouped with MDs, and the RN grouped with "No Title" for the purposes of statistical analyses.

Table 3.3 Subjects per General Educational Title, and Mean RN/CN Counts

General Titles	Number of Subjects	Total RN/CN	Mean (RN/CN per subject)	SD*
No title (includes 2 RNs)	41	55	2.50	2.70
PhD (includes 1 D. Sc. N.)	86	103	1.57	1.95
MD (includes 1 DVM)	28	44	1.34	2.36
Dual	12	30	1.20	3.29

* = Standard Deviation for Mean RN/CN per Subject

Those with a doctorate comprised the greatest proportion of those with misconduct findings (50.9 %), followed by those without a "titled" degree (e.g., masters student, RN, undergraduate) at 24.6%, an M.D. or D.V.M. (16.7%) and finally those with dual terminal degrees (7.2%). A statistical analysis of variance was performed (Table 3.4) showing no statistical significance to differences between the means of each group.

Table 3.4 ANOVA of Subject Educational Title and associated RN/CN Counts

	SS	df	MS	F	p
Between:	34.138	3	11.379	2.098	0.103
Within:	884.257	163	5.425		
Total:	918.395	166			

The professional position (i.e. employment status) held by the Subjects ranged from the undefined term "employee" to Director. Table 3.5 shows the retraction and correction notice counts for the Subjects assessed using the generalized position categories (as described in Table 2.1) as well as the mean of total retraction and correction counts.

Keeping in mind the inadequacies of the generalization of position titles, Professors had the greatest mean number of retractions. An ANOVA analysis of the number of retractions and

corrections in each general professional position category refuted the null hypothesis that all means were equivalent (Table 3.6).

Table 3.5 Subjects per Position Categories, and Mean RN/CN Counts

Position Category	**Number of Subjects**	**Total RN/CN**	**Mean** (RN/CN per subject)	**SD***
Assistant or Associate Professor	32	60	1.88	2.56
Director or Department Chair	6	16	2.67	3.27
Doctoral Student	9	15	1.67	1.36
Graduate Student	16	19	1.19	1.68
Medical Resident or Student	8	2	0.25	0.46
Postdoctoral	38	39	1.03	1.17
Primary Researcher	6	21	3.50	3.99
Professor	9	44	4.89	4.99
Research Associate	27	15	0.56	0.85
Technician	16	1	0.06	0.25

* = Standard Deviation for Mean RN/CN per Subject

The regression analysis of the trend line shows a weak correlation (Figure 3.1). It thus appears that there was no discernable pattern relatable to position categories, although some categories may have had a larger or smaller proportion of retractions and corrections affiliated with them.

Table 3.6 ANOVA of Subject Position Category and RN/CN Counts.

	SS	**df**	**MS**	**F**	**p**
Between:	218.045	9	24.227	5.725	0.000
Within:	664.413	157	4.232		
Total:	882.459	166			

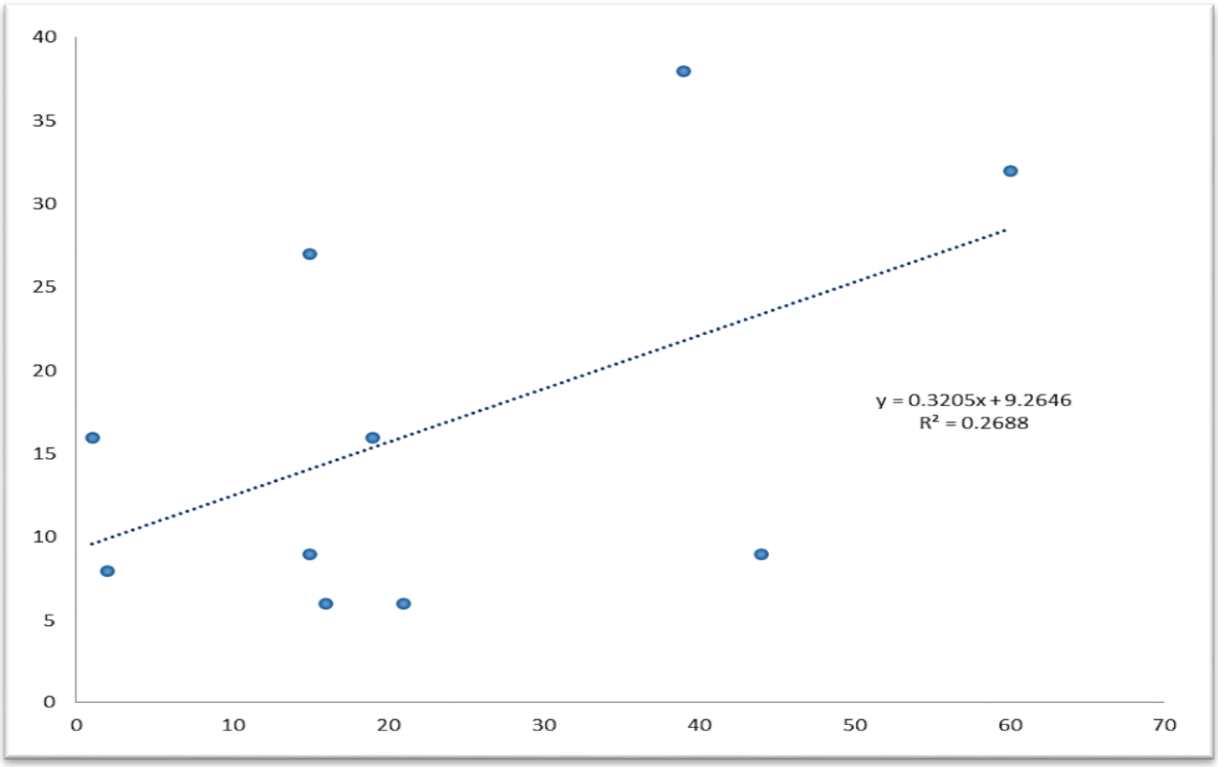

Figure 3.1 Total RN/CN vs Subjects in Generalized Position Title

3.2 Subjects and Associated Retractions and Corrections

Among the 84 final ORI misconduct findings (50.3%) had no associated articles, 24 Subjects had ORI findings that expressly stated that no articles had been affected by the referenced misconduct (Table 3.7).

Table 3.7 Subjects of ORI findings with No Affected Articles

Subject	Date of ORI Finding	Subject	Date of ORI Finding
Apte, Aaron	3/28/1996	Harrington, Melissa A	10/23/1996
Boone, James B Jr	2/10/1997	Karunakaran, Thonthi	7/17/2003
Briggs-Brown, Nellie	1/25/1999	Kerr, Catherine	8/30/1995
Caruso, Keith A	4/6/1994	King, Cynthia	4/6/1998
Coyle, Catherine	3/27/1995	Kurtzman, James T	3/18/1995
Daubert, Gail L	3/4/1996	Leonhard, Christopher	9/8/1997

Table 3.7 (Continued)

Subject	Date of ORI Finding	Subject	Date of ORI Finding
Misra, Manoj	4/7/1997	Shang, Xiaomin	9/29/1997
Munjee, Shaan F	12/17/2001	Shelley, Craig T	4/7/1993
Portuese, Enrico	3/25/1997	Tanner, Vivian N	2/21/1995
Ramasubban, Sheela	5/18/1993	Thwaites, Richard	10/03/1995
Sanchez, David D	9/4/2001	Washabaugh, Michael W	5/7/1996
Sanyak, Shamarendra	9/16/2011	Whitters, Eric	11/6/1996

3.2.1 ORI-Referenced Retraction and Correction Notices.

The remaining 83 Subjects had a total of 225 articles associated with them as referenced in their ORI misconduct findings. 36 Subjects (21.6 %) had one published article associated with misconduct, while 13 Subjects (7.8%) had 5 or more published articles associated with their misconduct. Table 3.8 shows article counts per ORI finding for each Subject..

Table 3.8 Article Counts per ORI finding per Subject

Name	ORI Article #'s	Name	ORI Article #'s	Name	ORI Article #'s
Abbs, James H	1	Murillo, Carlos A	1	Fogel, Robert B	2
Arichi, Tatsumi	1	Prabhakaran, Kartik	1	Friedman, Andrew	2
Arnold, Steven F	1	Prasad, M Renuka	1	Horvath, Emily M	2
Chang, Hung-Shu	1	Rooney, John W	1	Kumar, Vipin	2
Constantoulakis, Pantelis	1	Roy, Samar N	1	Liburdy, Robert P	2
Deng, Zhong Bin	1	Saleh, Ayman	1	Mayack, Shane	2
French, Randall P	1	Shapiro, David N	1	Miller, Michael W	2
Garey, Caroline E	1	Shin, Junghee	1	Nguyen, Mai	2
Goodwill, Meleik	1	Siddiqui, Farooq A	1	Paparo, Anthony A	2
Handa, Atsushi	1	Smith, Timothy R	1	Ramalingam, Tirunelveli	2
Herman, Terence S	1	Stricker, Raphael B	1	Ravindranath, Mepur H	2
Hiserodt, John C	1	Tewari, Anand	1	Thiruchelvam, Mona	2
Hoffmann, Bernd	1	Venters, Homer D	1	Tracy, Robert B	2
Huang, Chang-Fen	1	Xu, Jianhua (James)	1	Urban, James	2
Jiao, Shoushu	1	Yao, Zhenhai	1	Wang, Sheng	2
Jorge-Rivera, Juan Carlos	1	Zhang, Shuang-Qing	1	Zhu, Kui	2
Lee, Cathy Q	1	Aronica, Susan	2	Gu, Peili	3
Li, Xiaowu	1	Bois, Philippe	2	Lin, Kuie-Fu (Tom)	3
Lilly, Jason W	1	Boisse-Duplan, Martin	2	London, Jill A	3
Matsuguchi, Tetsuya	1	Duan, Lingxun	2	Muenchen, Heather J	3

Table 3.8 (Continued)

Name	ORI Article #'s	Name	ORI Article #'s	Name	ORI Article #'s
Paul, Saptarshi	3	Brodie, Scott J	4	Gelband, Craig H	8
Reisine, Terry D	3	Lee, Tian-Shing	4	Leadon, Steven Anthony	8
Roovers, Kristin	3	Angelides, Kimon J	5	Ninnemann, John L	9
Sezen, Bengu	3	Simmons, William A	5	Poehlman, Eric T	9
Sperber, Kirk	3	Elton, Terry S	6	Sudbø, Jon	9
Sun, Weidong	3	Contreras, Juan Luis R	7	Smart, Eric J	10
Weiser, Weishu Y	3	Hajra, Amitav	7	Thomas, Judith M	15
Wolfort, Ryan M	3	Van Parijs, Luk	7		

The review of MEDLINE and PUBMED databases and the Google Scholar website for each Subject resulted in the same 84 ORI Subjects with no articles, retraction or correction notices associated with the ORI-related misconduct. The remaining 83 Subjects, however, had a total of 231 articles associated with the ORI misconduct findings. The retractions and corrections located in the ORI findings and database searches for the 167 Subjects are shown in Tables 3.9 and 3.10, respectively. Five of the 231 articles were not mentioned in the ORI findings, but were clearly related by either mention of the ORI misconduct finding in the retraction or correction notice, or by similarities in time and topic to other retracted or corrected articles.

Table 3.9 Retraction Counts per Type per Subject

Author	RN HRM	RN Error	RN NR	RN NFI	Total
Abbs, James H	1	0	0	0	1
Afshar, Nima	0	0	0	0	0
Altman, Robert J	0	0	0	0	0
Angelides, Kimon J	3	0	0	0	3
Apte, Aaron	0	0	0	0	0
Arichi, Tatsumi	1	0	0	0	1

Table 3.9 (Continued)

Author	RN HRM	RN Error	RN NR	RN NFI	Total
Arnold, Steven F	0	0	1	0	1
Aronica, Susan	2	0	0	0	2
Bartsch, Lois	0	0	0	0	0
Bednarik, Daniel P	0	0	0	0	0
Bhrigu, Vipul	0	0	0	0	0
Bois, Philippe	0	1	0	0	1
Boisse-Duplan, Martin	1	0	0	0	1
Boone, James B Jr	0	0	0	0	0
Briggs-Brown, Nellie	0	0	0	0	0
Brodie, Scott J	2	0	0	0	2
Bryant, Joy	0	0	0	0	0
Caruso, Keith A	0	0	0	0	0
Chang, Hung-Shu	1	0	0	0	1
Cheskis, Boris	0	2	0	0	2
Constantoulakis, Pantelis	0	0	1	0	1
Contreras, Juan Luis R	0	6	0	0	6
Coyle, Catherine	0	0	0	0	0
Daubert, Gail L	0	0	0	0	0
Deng, Zhong Bin	0	1	0	0	1
Dreyer, Evan B	0	0	0	0	0
Duan, Lingxun	0	1	0	0	1
Eagan, George E	0	0	0	0	0
Eierman, David F	0	0	0	0	0
Elton, Terry S	2	0	3	1	6
Fogel, Robert B	2	0	0	0	2
Fossel, Eric T	0	0	0	0	0
Francis, Peter J	0	0	0	0	0
French, Randall P	0	0	0	0	0
Friedman, Andrew	0	2	0	0	2
Ganz, Michael B	0	0	0	0	0
Garey, Caroline E	0	1	0	0	1
Gelband, Craig H	1	0	0	4	5
Glennon, Eileen	0	0	0	0	0
Goodwill, Meleik	0	1	0	0	1
Goodwin, Elizabeth	0	0	0	0	0
Grol, Jessica Lee	0	0	0	0	0
Gu, Peili	0	1	0	0	1
Guffee, Judy	0	0	0	0	0
Hajra, Amitav	0	2	1	0	3

Table 3.9 (Continued)

Author	RN HRM	RN Error	RN NR	RN NFI	Total
Hampton, J Keith	0	0	0	0	0
Handa, Atsushi	2	0	0	0	2
Hanneken, Vickie L	0	0	0	0	0
Harrington, Melissa A	0	0	0	0	0
Herman, Terence S	0	0	0	0	0
Hiserodt, John C	0	0	0	0	0
Ho, John L	0	0	0	0	0
Hoffmann, Bernd	0	0	1	0	1
Horvat, Regina D	0	0	0	0	0
Horvath, Emily M	3	0	0	0	3
Huang, Chang-Fen	0	0	1	1	2
Jacoby, David R	0	0	0	0	0
Jiao, Shoushu	0	1	0	0	1
Jin, Wei	0	0	0	0	0
Jorge-Rivera, Juan Carlos	1	0	0	0	1
Kammer, Gary M	0	0	0	0	0
Karunakaran, Thonthi	0	0	0	0	0
Kerr, Catherine	0	0	0	0	0
Kim, Sinae	0	0	0	0	0
King, Cynthia	0	0	0	0	0
Koltover, Ilya	0	0	0	0	0
Kornak, Paul H	0	0	0	0	0
Kumar, Vipin	0	1	1	0	2
Kurtzman, James T	0	0	0	0	0
Langlois, Paul F	0	0	0	0	0
Layman, Diana	0	0	0	0	0
Leadon, Steven Anthony	3	3	0	0	6
Lee, Cathy Q	1	0	0	0	1
Lee, Tian-Shing	0	1	0	1	2
Leonhard, Christopher	0	0	0	0	0
Li, Fugang	0	0	0	0	0
Li, Xiaowu	1	0	0	0	1
Liburdy, Robert P	0	0	0	0	0
Lilly, Jason W	1	0	0	0	1
Lin, James C	0	0	0	0	0
Lin, Kuie-Fu (Tom)	0	0	0	0	0
London, Jill A	1	0	0	0	1
Lorenzo, Nicholas Y	0	0	0	0	0
Lowe, Patrina	0	0	0	0	0

Table 3.9 (Continued)

Author	RN HRM	RN Error	RN NR	RN NFI	Total
Ma, Jian	0	0	0	0	0
Manojlovic, Marija	0	0	0	0	0
Marcus, Rebecca	0	0	0	0	0
Matsuguchi, Tetsuya	0	0	0	0	0
Mayack, Shane	2	0	0	0	2
McMaster, Nicolas	0	0	0	0	0
Miller, Michael W	3	0	0	0	3
Misra, Manoj	0	0	0	0	0
Monte, Scott E	0	0	0	0	0
Morrow, Aaron J	0	0	0	0	0
Muchowski, Paul J	0	0	0	0	0
Muenchen, Heather J	2	0	0	1	3
Mungekar, Sagar S	0	0	0	0	0
Munjee, Shaan F	0	0	0	0	0
Murillo, Carlos A	1	0	0	0	1
Nguyen, Mai	0	0	0	1	1
Ningaraj, Nagendra S	0	0	0	0	0
Ninnemann, John L	0	4	0	0	4
Paez, Gerardo L	0	0	0	0	0
Paparo, Anthony A	0	0	0	0	0
Parachuri, Durga K	0	0	0	0	0
Park, George A.	0	0	0	0	0
Park, Hyuk Jong	0	0	0	0	0
Paul, Saptarshi	0	3	0	0	3
Pender, Benjamin	0	0	0	0	0
Poehlman, Eric T	6	0	0	0	6
Poisson, Roger	0	0	0	0	0
Portuese, Enrico	0	0	0	0	0
Prabhakaran, Kartik	0	0	1	0	1
Prasad, M Renuka	1	0	0	0	1
Radolf, Justin	0	0	0	0	0
Ramalingam, Tirunelveli	0	1	1	0	2
Ramasubban, Sheela	0	0	0	0	0
Ravindranath, Mepur H	0	0	0	0	0
Reisine, Terry D	0	0	0	0	0
Robinson, Clifford R	0	0	0	0	0
Rooney, John W	0	0	1	0	1
Roovers, Kristin	0	2	0	0	2
Roy, Samar N	0	0	1	0	1

Table 3.9 (Continued)

Author	RN HRM	RN Error	RN NR	RN NFI	Total
Rudick, Charles N	0	0	0	0	0
Saleh, Ayman	0	0	0	0	0
Sanchez, David D	0	0	0	0	0
Sanyak, Shamarendra	0	0	0	0	0
Sezen, Bengu	0	0	6	0	6
Shang, Xiaomin	0	0	0	0	0
Shapiro, David N	0	0	0	0	0
Shelley, Craig T	0	0	0	0	0
Shin, Junghee	0	1	0	0	1
Shishov, Michael	0	0	0	0	0
Siddiqui, Farooq A	0	0	0	0	0
Simmons, William A	0	0	4	0	4
Smart, Eric J	10	0	0	0	10
Smith, Timothy R	1	0	0	0	1
Solomon, Nicola	0	0	0	0	0
Sotolongo, Jose R	1	0	0	0	1
Sperber, Kirk	0	3	0	0	3
Stricker, Raphael B	1	0	0	0	1
Sudbø, Jon	9	0	0	0	9
Sun, Weidong	0	0	2	0	2
Tanner, Vivian N	0	0	0	0	0
Tewari, Anand	0	1	0	0	1
Thiruchelvam, Mona	1	0	0	1	2
Thomas, Judith M	0	11	0	1	12
Thwaites, Richard	0	0	0	0	0
Tomasula, John J	1	0	0	0	1
Tracy, Robert B	2	0	0	0	2
Urban, James	0	1	0	0	1
Van Parijs, Luk	4	1	0	0	5
Venters, Homer D	0	0	0	0	0
Wang, Sheng	1	1	0	0	2
Washabaugh, Michael W	0	0	0	0	0
Weiser, Weishu Y	3	1	0	0	4
Whitters, Eric	0	0	0	0	0
Wolfort, Ryan M	0	0	0	0	0
Woreta, Hiwot A	0	0	0	0	0
Xiong, Momiao	0	0	0	0	0
Xu, Jianhua (James)	1	0	0	0	1
Yang, Jusan	0	0	0	0	0

Table 3.9 (Continued)

Author	RN HRM	RN Error	RN NR	RN NFI	Total
Yao, Zhenhai	0	0	0	1	1
Yuan, Gang	0	0	0	0	0
Zhang, Shuang-Qing	0	0	0	1	1
Zhao, Lingjie	0	0	0	0	0
Zhu, Kui	1	0	1	1	3
Totals	**80**	**54**	**26**	**14**	**174**

Table 3.10 Correction Counts per Type per Subject

Author	CN HRM	CN Error	CN NR	CN NFI	Total
Abbs, James H	0	0	0	0	0
Afshar, Nima	0	0	0	0	0
Altman, Robert J	0	0	0	0	0
Angelides, Kimon J	0	0	0	0	0
Apte, Aaron	0	0	0	0	0
Arichi, Tatsumi	0	1	0	0	1
Arnold, Steven F	0	0	0	0	0
Aronica, Susan	0	0	0	0	0
Bartsch, Lois	0	0	0	0	0
Bednarik, Daniel P	0	0	0	0	0
Bhrigu, Vipul	0	0	0	0	0
Bois, Philippe	0	1	0	0	1
Boisse-Duplan, Martin	0	0	0	0	0
Boone, James B Jr	0	0	0	0	0
Briggs-Brown, Nellie	0	0	0	0	0
Brodie, Scott J	2	0	0	0	2
Bryant, Joy	0	0	0	0	0
Caruso, Keith A	0	0	0	0	0
Chang, Hung-Shu	0	0	0	0	0
Cheskis, Boris	0	0	0	0	0
Constantoulakis, Pantelis	0	0	0	0	0
Contreras, Juan Luis R	0	0	0	1	1
Coyle, Catherine	0	0	0	0	0
Daubert, Gail L	0	0	0	0	0
Deng, Zhong Bin	0	0	0	0	0
Dreyer, Evan B	0	0	0	0	0
Duan, Lingxun	0	5	0	0	5
Eagan, George E	0	0	0	0	0

Table 3.10 (Continued)

Author	CN HRM	CN Error	CN NR	CN NFI	Total
Eierman, David F	0	0	0	0	0
Elton, Terry S	0	0	0	0	0
Fogel, Robert B	0	0	0	0	0
Fossel, Eric T	0	0	0	0	0
Francis, Peter J	0	0	0	0	0
French, Randall P	0	1	0	0	1
Friedman, Andrew	0	0	0	0	0
Ganz, Michael B	0	0	0	0	0
Garey, Caroline E	0	0	0	0	0
Gelband, Craig H	3	0	0	0	3
Glennon, Eileen	0	0	0	0	0
Goodwill, Meleik	0	0	0	0	0
Goodwin, Elizabeth	0	0	0	0	0
Grol, Jessica Lee	0	0	0	0	0
Gu, Peili	0	1	0	0	1
Guffee, Judy	0	0	0	0	0
Hajra, Amitav	0	2	1	0	3
Hampton, J Keith	0	0	0	0	0
Handa, Atsushi	0	0	0	0	0
Hanneken, Vickie L	0	0	0	0	0
Harrington, Melissa A	0	0	0	0	0
Herman, Terence S	0	1	0	0	1
Hiserodt, John C	1	0	0	0	1
Ho, John L	0	0	0	0	0
Hoffmann, Bernd	0	0	0	0	0
Horvat, Regina D	0	0	0	0	0
Horvath, Emily M	0	0	0	0	0
Huang, Chang-Fen	0	0	0	0	0
Jacoby, David R	0	0	0	0	0
Jiao, Shoushu	0	0	0	0	0
Jin, Wei	0	0	0	0	0
Jorge-Rivera, Juan Carlos	0	0	0	0	0
Kammer, Gary M	0	0	0	0	0
Karunakaran, Thonthi	0	0	0	0	0
Kerr, Catherine	0	0	0	0	0
Kim, Sinae	0	0	0	0	0
King, Cynthia	0	0	0	0	0
Koltover, Ilya	0	0	0	0	0
Kornak, Paul H	0	0	0	0	0

Table 3.10 (Continued)

Author	CN HRM	CN Error	CN NR	CN NFI	Total
Kumar, Vipin	0	0	0	0	0
Kurtzman, James T	0	0	0	0	0
Langlois, Paul F	0	0	0	0	0
Layman, Diana	0	0	0	0	0
Leadon, Steven Anthony	0	0	2	0	2
Lee, Cathy Q	0	0	0	0	0
Lee, Tian-Shing	0	2	0	0	2
Leonhard, Christopher	0	0	0	0	0
Li, Fugang	0	0	0	0	0
Li, Xiaowu	0	0	0	0	0
Liburdy, Robert P	1	0	0	0	1
Lilly, Jason W	0	0	0	0	0
Lin, James C	0	0	0	0	0
Lin, Kuie-Fu (Tom)	1	0	0	2	3
London, Jill A	0	0	0	1	1
Lorenzo, Nicholas Y	0	0	0	0	0
Lowe, Patrina	0	0	0	0	0
Ma, Jian	0	0	0	0	0
Manojlovic, Marija	0	0	0	0	0
Marcus, Rebecca	0	0	0	0	0
Matsuguchi, Tetsuya	1	0	0	0	1
Mayack, Shane	0	0	0	0	0
McMaster, Nicolas	0	0	0	0	0
Miller, Michael W	0	0	0	0	0
Misra, Manoj	0	0	0	0	0
Monte, Scott E	0	0	0	0	0
Morrow, Aaron J	0	0	0	0	0
Muchowski, Paul J	0	0	0	0	0
Muenchen, Heather J	0	0	0	0	0
Mungekar, Sagar S	0	0	0	0	0
Munjee, Shaan F	0	0	0	0	0
Murillo, Carlos A	0	0	0	0	0
Nguyen, Mai	0	1	0	0	1
Ningaraj, Nagendra S	0	0	0	0	0
Ninnemann, John L	0	4	0	0	4
Paez, Gerardo L	0	0	0	0	0
Paparo, Anthony A	0	0	0	0	0
Parachuri, Durga K	0	0	0	0	0
Park, George A.	0	0	0	0	0

Table 3.10 (Continued)

Author	CN HRM	CN Error	CN NR	CN NFI	Total
Park, Hyuk Jong	0	0	0	0	0
Paul, Saptarshi	0	1	0	0	1
Pender, Benjamin	0	0	0	0	0
Poehlman, Eric T	3	0	0	0	3
Poisson, Roger	0	0	0	0	0
Portuese, Enrico	0	0	0	0	0
Prabhakaran, Kartik	0	0	0	0	0
Prasad, M Renuka	0	0	0	0	0
Radolf, Justin	0	0	0	0	0
Ramalingam, Tirunelveli	0	0	0	0	0
Ramasubban, Sheela	0	0	0	0	0
Ravindranath, Mepur H	0	1	0	0	1
Reisine, Terry D	0	3	0	0	3
Robinson, Clifford R	0	0	0	0	0
Rooney, John W	0	0	0	0	0
Roovers, Kristin	0	1	0	0	1
Roy, Samar N	0	0	0	0	0
Rudick, Charles N	0	0	0	0	0
Saleh, Ayman	0	1	0	0	1
Sanchez, David D	0	0	0	0	0
Sanyak, Shamarendra	0	0	0	0	0
Sezen, Bengu	0	0	0	0	0
Shang, Xiaomin	0	0	0	0	0
Shapiro, David N	0	1	0	0	1
Shelley, Craig T	0	0	0	0	0
Shin, Junghee	0	0	0	0	0
Shishov, Michael	0	0	0	0	0
Siddiqui, Farooq A	0	0	0	0	0
Simmons, William A	0	1	0	0	1
Smart, Eric J	0	0	0	0	0
Smith, Timothy R	0	0	0	0	0
Solomon, Nicola	0	0	0	0	0
Sotolongo, Jose R	0	0	0	0	0
Sperber, Kirk	0	2	0	0	2
Stricker, Raphael B	0	0	0	0	0
Sudbø, Jon	0	0	0	0	0
Sun, Weidong	0	0	0	0	0
Tanner, Vivian N	0	0	0	0	0
Tewari, Anand	0	1	0	0	1

Table 3.10 (Continued)

Author	CN HRM	CN Error	CN NR	CN NFI	Total
Thiruchelvam, Mona	0	0	0	0	0
Thomas, Judith M	0	2	0	0	2
Thwaites, Richard	0	0	0	0	0
Tomasula, John J	0	0	0	0	0
Tracy, Robert B	0	0	0	0	0
Urban, James	0	0	0	0	0
Van Parijs, Luk	2	1	0	1	4
Venters, Homer D	0	1	0	0	1
Wang, Sheng	0	0	0	0	0
Washabaugh, Michael W	0	0	0	0	0
Weiser, Weishu Y	0	0	0	0	0
Whitters, Eric	0	0	0	0	0
Wolfort, Ryan M	0	0	0	0	0
Woreta, Hiwot A	0	0	0	0	0
Xiong, Momiao	0	0	0	0	0
Xu, Jianhua (James)	0	0	0	0	0
Yang, Jusan	0	0	0	0	0
Yao, Zhenhai	0	0	0	0	0
Yuan, Gang	0	0	0	0	0
Zhang, Shuang-Qing	0	0	0	0	0
Zhao, Lingjie	0	0	0	0	0
Zhu, Kui	0	0	0	0	0
Totals	**14**	**35**	**3**	**5**	**57**

Of these 83 Subjects, 51 Subjects (30.5% of the total Subject dataset) had only retraction notices, 11 Subjects (6.59% of the total Subject dataset) had only correction notices, and 21 Subjects (12.6% of the total Subject dataset) had both retraction and correction notices. Overall, roughly 56.9% of those with misconduct findings had no retraction notices associated with their misconduct, while 43.1% of the Subjects had at least one retraction associated with their misconduct. In examining the separate categories for retraction and correction notices, 80 (46%) of the 174 retraction notices indicated research misconduct as the reason for the retraction, while 54 retraction notices (31%) were attributed to some type of error, either in research methods or

data analysis. Of the 57 correction notices, 14 (24.6%) were attributed to research misconduct, while 35 (61.4%) correction notices were attributed to error. Altogether, only 94 (40.7%) of the notices arising from an official finding of misconduct gave misconduct as a foundation for article retraction or correction. Figure 3.2 displays a bar graph showing the number of Subjects per total number of retractions and corrections combined. Figures 3.3 through 3.7 compare the number of retractions and corrections per type of notice.

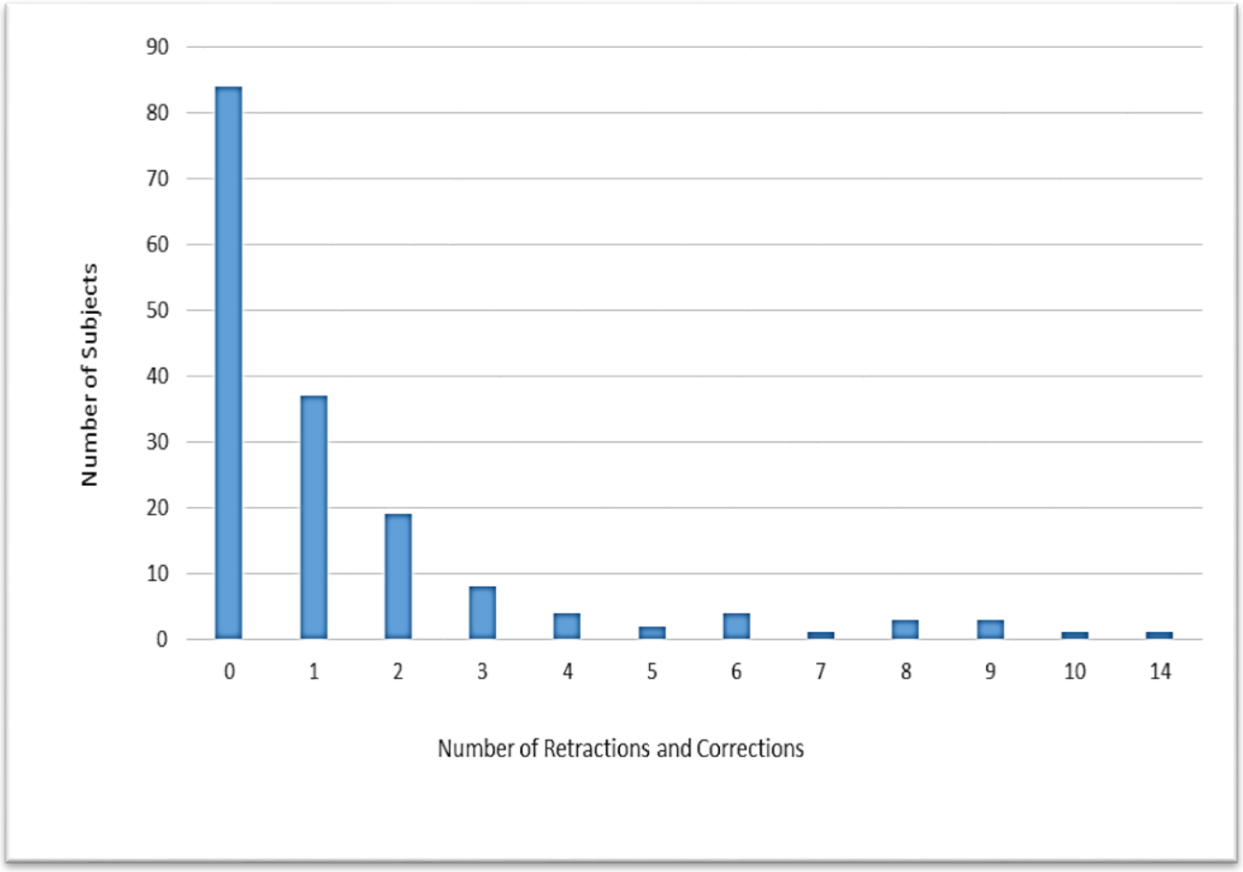

Figure 3.2 Number of Subjects per Total Retraction and Correction Counts

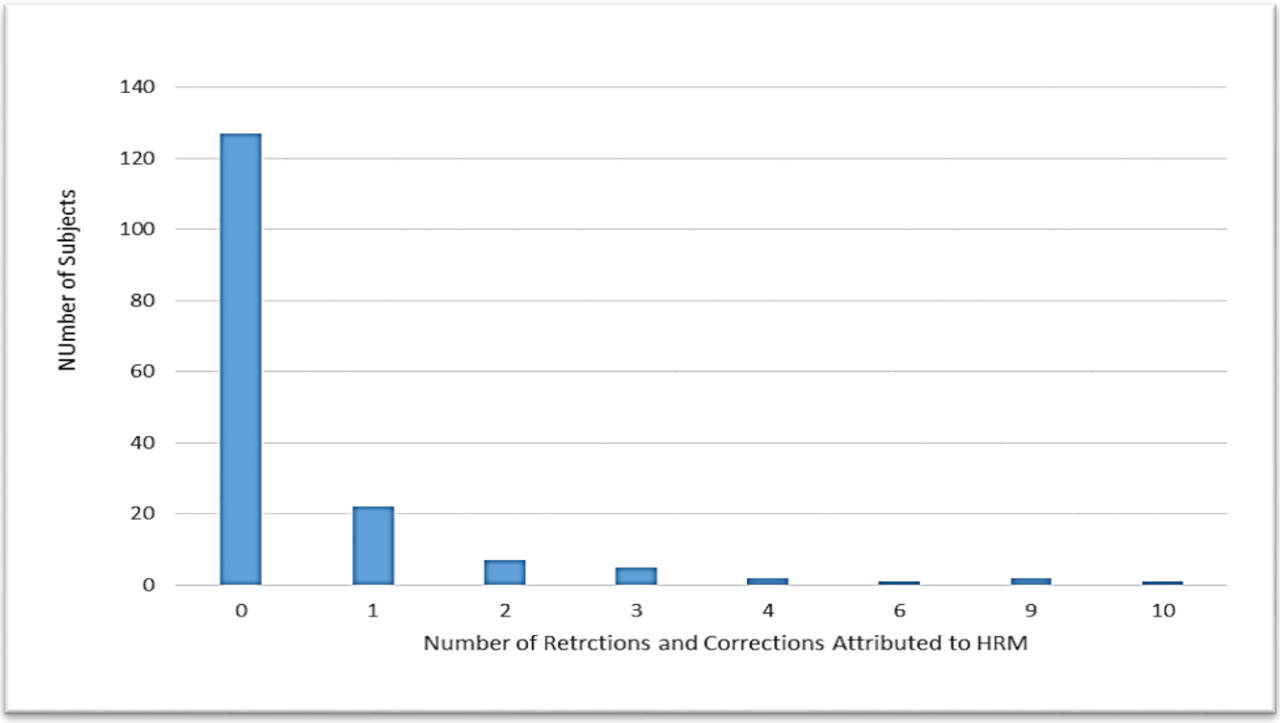

Figure 3.3 Number of Subjects per Total HRM Retraction and HRM Correction Counts

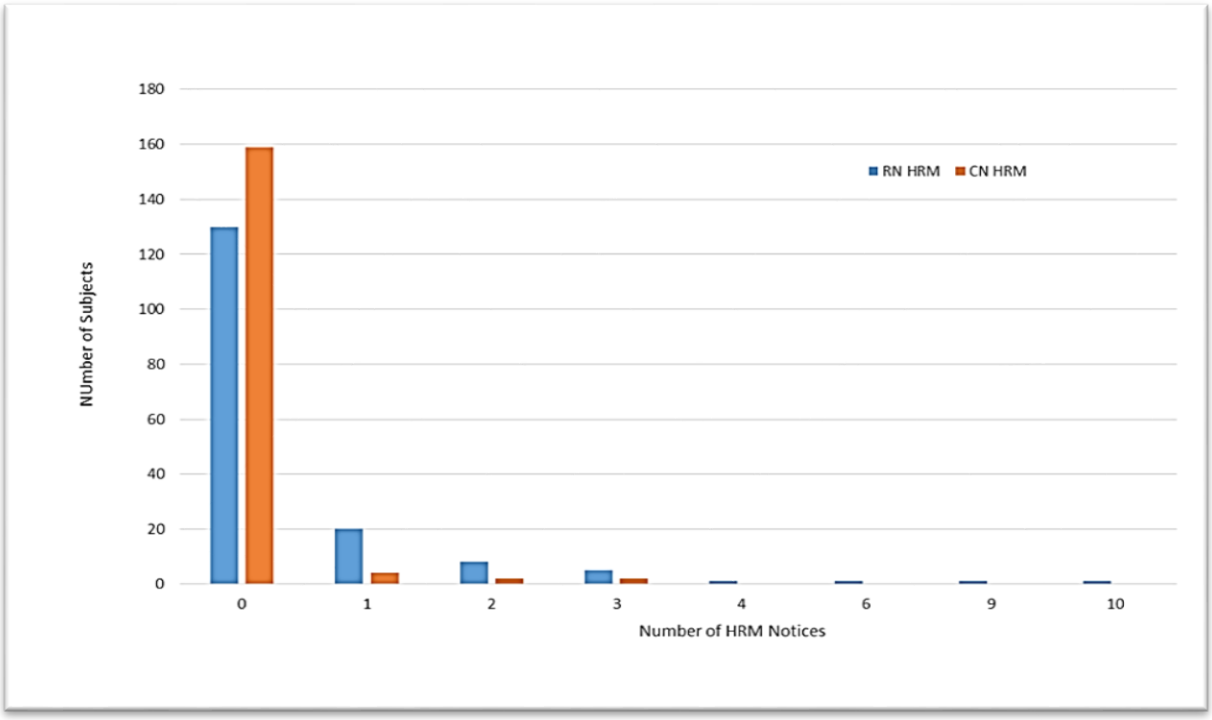

Figure 3.4 Number of Subjects per HRM Retraction and HRM Correction Counts

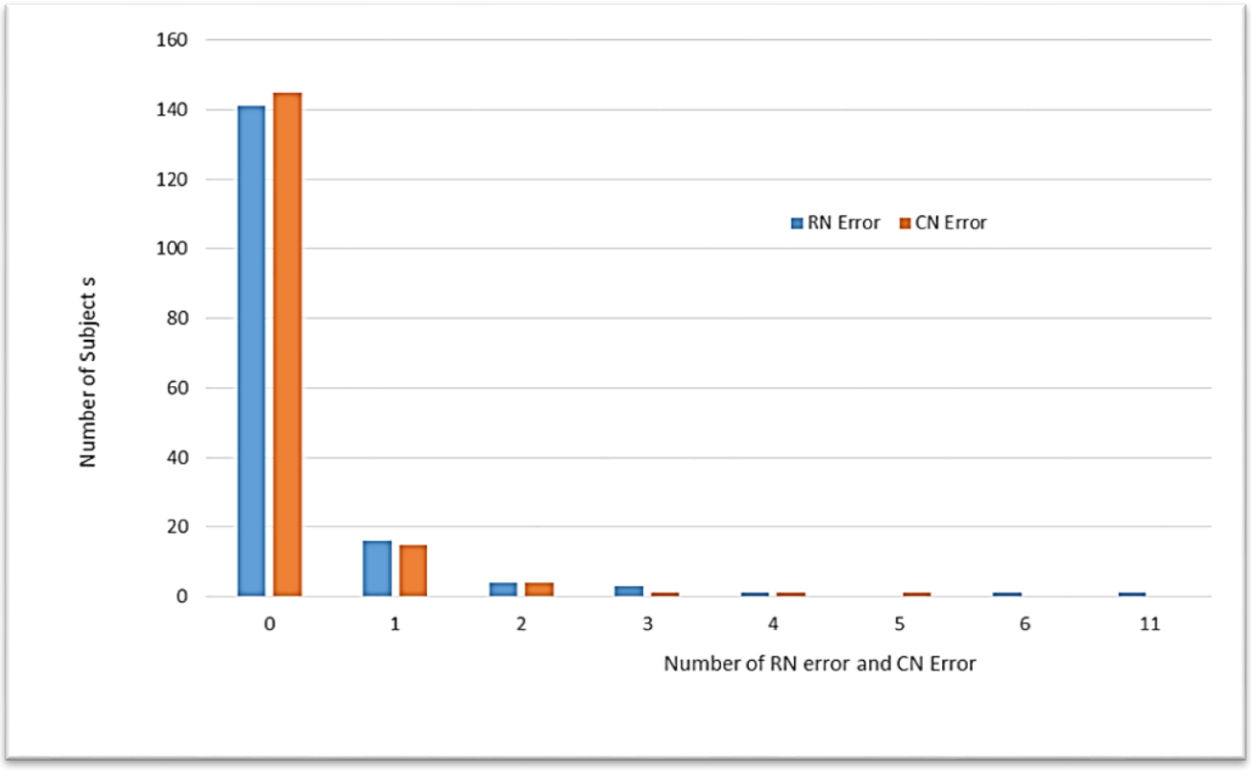

Figure 3.5 Number of Subjects per Error Retraction and Error Correction Counts

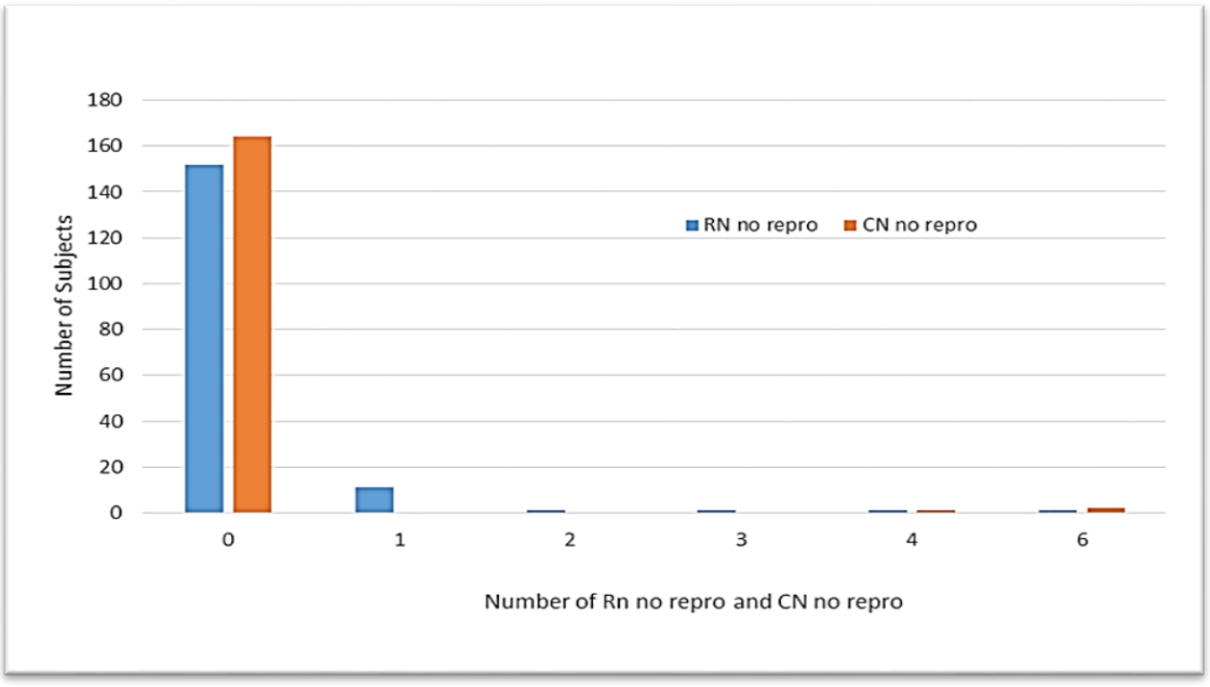

Figure 3.6 Number of Subjects per NR Retraction and NR Correction Counts

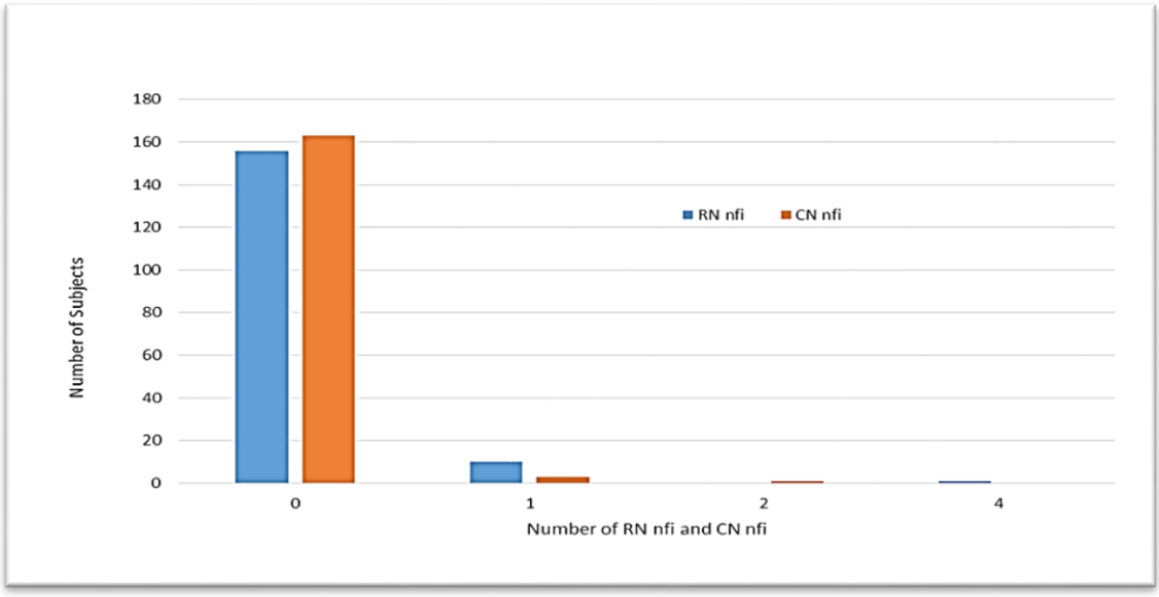

Figure 3.7 Number of Subjects per NFI Retraction and NFI Correction Counts

The total number of retractions and corrections was plotted against the year of ORI finding (Figure 3.8), as was the total number of retractions only (Figure 3.9).

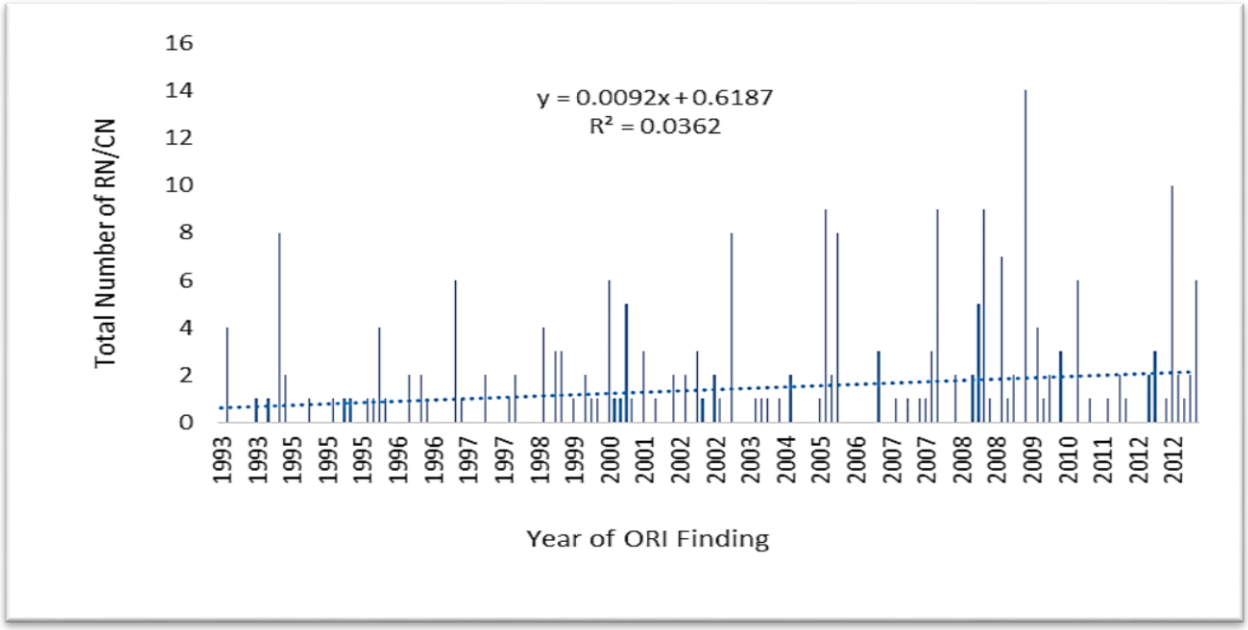

Figure 3.8 Total Number of RNs and CNs per Year of ORI Finding

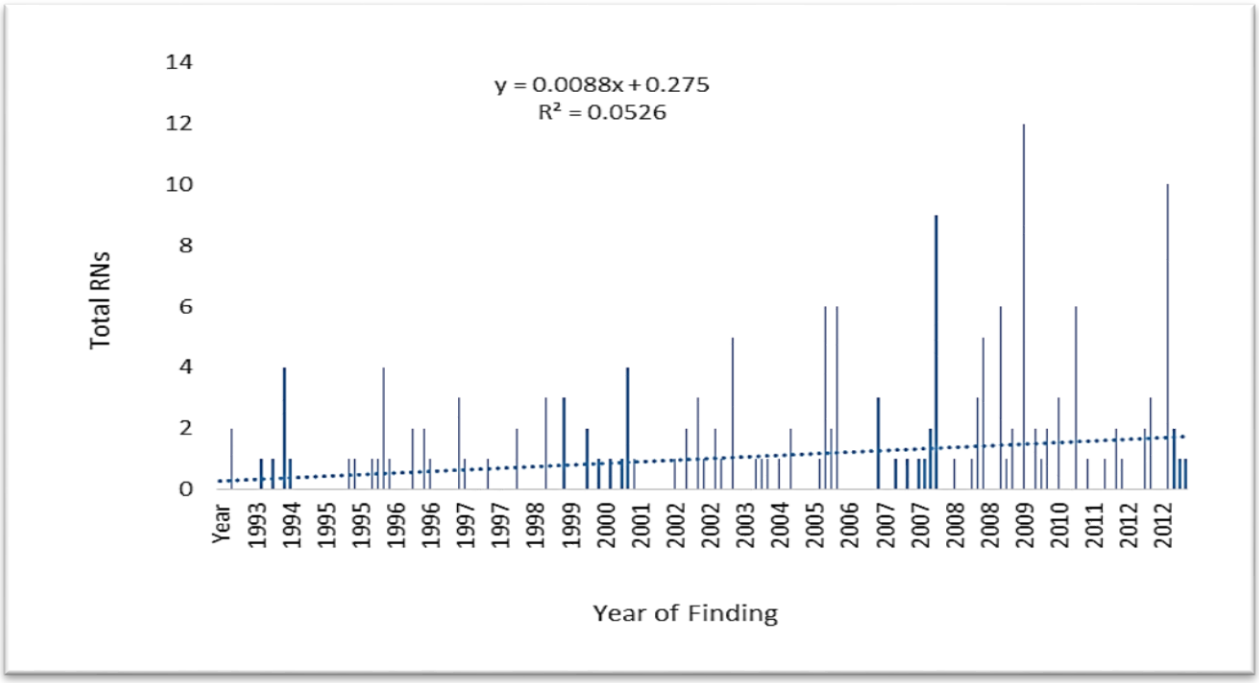

Figure 3.9 Total Number of RNs per Year of ORI Finding

3.2.2 Non-ORI-Referenced Articles with Retraction or Correction Notices

The five articles not mentioned in the ORI findings demonstrated a relation to the misconduct finding by either mention of the ORI misconduct finding in the retraction or correction notice or by similarities in time and topic to other retracted or corrected articles**.** The retraction and correction notices were included in total counts, but any statistical analyses of the retractions and corrections as an isolated category would be of no value as sample size is too small. No retraction or correction notice of any kind could be located for 13 articles identified within the ORI misconduct findings (Table 3.11)

Table 3.11 Non-ORI-Referenced with Retraction or Correction Notices

Subject (Year of Finding)	Article	RN or CN
Elton, Terry S (2013)	Martin MM, Lee EJ, Buckenberger JA, Schmittgen TD, Elton TS. 2006. MicroRNA-155 regulates human angiotensin II type 1 receptor expression in fibroblasts. *The Journal of Biological Chemistry*. 281(27), 18277-84.	RN NFI. 2013. J Biol Chem. 288(6): 226
Horvath, Emily (2010)	Horvath EM, Tackett L, Elmendorf JS. 2008. A novel membrane-based anti-diabetic action of atorvastatin. *Biochemical and Biophysical Research Communications*. 372(4):639-43.	RN HRM. 2010. *Biochemical and Biophysical Research Communications*. 401 (2): 319
van, Parijs, Luk (2008)	1. Refaeli Y, van Parijs L, Stephen I. Alexander SI, Abbas AK. 2002. Interferon γ is required for activation-induced death of T lymphocytes. *Journal of Experimental Medicine*. 196(7):999–1005. 2. Kelly E, Won A, Refaeli Y, van Parijs L. 2002. IL-2 and related cytokines can promote T cell survival by activating AKT. *Journal of Immunology*. 168(2):597-603.	1. CN Error. 2012. *Journal of Experimental Medicine*. 209(5): 1049 2. CN p/r HRM. 2007. *Journal of Immunology*. 179(12): 8569.
Weiser, Weishu (1995)	Orme I M, Furney SK, Skinner PS, Roberts AD, Brennan PJ, Russell DG, Shiratsuchi H, Ellner JJ, Weiser WY. 1993. Inhibition of growth of Mycobacterium avium in murine and human mononuclear phagocytes by migration inhibitory factor. *Infection and immunity* 61(1):338-342.	RN Error: 1994, *Infection and Immunity*. 62 (5): 2141. Related by topic and time

3.2.3 ORI-Referenced Articles with No Retractions or Corrections

No retraction or correction notice of any kind could be located for 13 articles identified within the ORI misconduct findings (Table 3.12)

Table 3.12 Subjects with Articles Referenced in ORI finding with no known RN or CN

Subject (Year of Finding)	**Publication with no located RN or CN**	**Total (located) RN/CN for Subject**
Angelides, Kimon J (1999)	1) Black JA, Friedman B, Waxman SG, Elmer LW, Angelides KJ. 1989. Immuno-ultrastructural localization of sodium channels at nodes of Ranvier and perinodal astrocytes in rat optic nerve. *Proc. R. Soc. London B.* 238:39-51. 2) Minturn JE, Sontheimer H, Black JA, Angelides KJ, Ransom BR, Ritchie JM, Waxman SG. 1991. Membrane-associated sodium channels and cytoplasmic precursors in glial cells. *Ann. N.Y. Acad. Sci.* 633:255-271.	3
Elton, Terry S (2012)	Martin MM, Buckenberger JA, Knoell DL, Strauch AR, Elton TS. 2006. TGF-beta(1) regulation of human AT1 receptor mRNA splice variants harboring exon 2. *Mol Cell Endocrinol 2*49(1-2):21-31.	6
Gu, Peili (2008)	Gu P, LeMenuet D, Chung A, Cooney AJ. 2006. Differential Recruitment of Methylated CpG Binding Domains [MBDs] by the Orphan Receptor GCNF Initiates the Repression and Silencing of Oct4 Expression. *Mol. Cell. Biology*. 26(24):9471-9483.	2
Liburdy, Robert P (1999)	Liburdy, RP. 1992. Biological interactions of cellular systems with time-varying magnetic fields. *Ann. N.Y. Acad. Sci.* 649:74-95.	1
Nguyen, Mai (2008)	Liu Y, Wang JL, Chang H, Barsky SH, Nguyen M. 2000. Breast-cancer diagnosis with nipple fluid bFGF. *The Lancet*. 356:567-569.	2
Ninnemann, John L (1994)	Ninnemann JL, Stockland AE, Condie JT. 1983. Induction of prostaglandin synthesis-dependent suppressor cells with endotoxin: occurrence in patients with thermal injuries. *Journal of Clinical Immunology*. *3*(2):142-50.	8
Paparo, Anthony A (1993)	1) Paparo AA, Murphy JA. 1975. The effect of STH on the SEM and frequency response of the branchial nerve in *Mytilus edulis* as it relates to ciliary activity. *Comparative Biochemistry and Physiology. C: Comparative Pharmacology*. 51(2):165-7. 2) Paparo AA, Murphy JA. 1975. The effect of STH and 6-OH-dopa on the SEM of the branchial nerve and visceral ganglion of the bivalve *Elliptio complanata* as it relates to ciliary activity. *Comparative Biochemistry and Physiology. C: Comparative Pharmacology*. 51(2):169-70.	0

Table 3.12 (Continued)

Subject (Year of Finding)	Publication with no located RN or CN	Total (located) RN/CN for Subject
Ravindranath, Mepur H (2012)	Ravindranath MH, Yesowitch P, Sumobay C, Morton DL. 2007. Glycoimmunomics of human cancer: Current concepts and future perspectives. *Future Oncology* 3(2):201-214.	1
Shapiro, David N (1997)	Sublett JE, Jeon IS, Shapiro DN. 1995. The aveolar rhabdomyosarcoma PAX3/FKHR fusion protein is a transcriptional activator. *Oncogene* 11:545-552.	1
Sun, Weidong (1997)	Sun W, Chen X, Chantler PD. 1994. Inhibition of neuritogenesis by antisense arrest of the expression of a specific isoform of brain myosin II. *Journal of Muscle Research and Cell Motility* 15:184-185.	2
Urban, James (1995)	Urban JL, Kumar V, Kono DH, Gomez C, Horvath SJ, Clayton J, Ando DG, Sercarz EE, Hood L. 1988. Restricted use of T cell receptor V genes in murine autoimmune encephalomyelitis raises possibilities for antibody therapy. *Cell*. 54(4):577–592.	1

3.3 Journals and Retraction and Correction Notices

Over 100 journals were associated with publishing the articles referenced in and related to the ORI misconduct findings. Of the 100 journals in which either retractions or corrections were published, 18 journals (18%) had no published retraction notices and 64 journals (64%) had no published corrections. 49 journals (49%) had only one retraction published while 36 journals (36%) had only one published correction. Looking at the combination of total counts of retraction and correction notices (Table 3.13), roughly three-quarters of the journals had published only one or two articles that were retracted or corrected for misconduct. Only three journals had totals greater than10 misconduct-associated retractions and corrections: P*NAS*, *Journal of Immunology*, and *Journal of Biological Chemistry*.

Table 3.13 Journals and Related Retraction and Correction Counts

Journal	RN HRM	RN Error	RN NR	RN NFI	CN HRM	CN Error	CN NFI	CN NR	Totals
Acta Obstetricia et Gynecologica Scandinavica	1	0	0	0	0	0	0	0	1
American Journal of Pathology	0	0	0	0	1	0	0	0	1
American Journal of Physiology - Endocrinology and Metabolism	0	0	0	0	1	0	0	0	1
American Journal of Physiology -Lung cellular and molecular physiology	0	0	1	0	0	0	0	0	1
American Journal of Physiology: Cellular Physiology	3	0	0	0	0	0	0	0	3
Annals of Internal Medicine	1	0	0	0	0	0	0	0	1
Biochemical and Biophysical Research Communications	1	1	2	0	0	0	0	0	4
Biochemistry	0	2	0	0	0	1	0	0	3
Biochimica et Biophysica Acta	0	0	1	1	0	0	0	0	2
Biomedical Chromatography	0	0	0	1	0	0	0	0	1
Blood	2	0	0	0	0	1	0	0	3
Brain Research	2	0	0	0	0	0	1	0	3
Cancer Research	0	1	0	0	0	0	0	0	1
Carcinogenesis	1	0	0	0	0	0	0	0	1
Cell	0	2	0	0	0	0	0	0	2
Cellular Immunity	0	1	0	0	0	0	0	0	1
Chemical Senses	1	0	0	0	0	0	0	0	1
Circulation Research	0	0	0	0	2	0	0	0	2
Clinical Cancer Research	1	0	0	1	0	0	0	0	2
Clinical Medicine & Research	1	0	0	0	0	0	0	0	1
Coronary Artery Disease	0	0	0	0	1	0	0	0	1
Current Opinion in Investigational Drugs	0	0	0	1	0	0	0	0	1

Table 3.13 (Continued)

Journal	RN HRM	RN Error	RN NR	RN NFI	CN HRM	CN Error	CN NFI	CN NR	Totals
Current Opinion in Molecular Therapeutics	0	0	0	0	0	0	1	0	1
Current Opinion in Organ Transplantation	0	0	0	0	0	2	1	0	3
Developmental Biology	0	0	0	0	0	1	0	0	1
Developmental Cell	0	1	0	0	0	0	0	0	1
Developmental Neuroscience	1	0	0	0	0	0	0	0	1
Diabetes	0	0	0	1	0	0	0	0	1
Diabetes and Metabolism	1	0	0	0	0	0	0	0	1
EMBO Journal	2	1	0	0	1	0	0	0	4
Endocrinology	2	0	0	0	0	0	0	0	2
Environmental Health Perspectives	1	0	0	0	0	0	0	0	1
European Journal of Clinical Investigation	1	0	0	0	0	0	0	0	1
FEBS Letters	0	0	0	1	1	0	0	0	2
Fertility and Sterility	0	1	0	0	0	0	0	0	1
Gastroenterology	1	0	0	0	0	0	0	0	1
Genes & Development	0	0	1	0	0	0	0	0	1
Genes, Chromosomes & Cancer	0	0	0	0	0	0	0	1	1
Genomics	0	1	0	0	0	0	0	0	1
Glia	1	0	0	0	0	0	0	0	1
Graft	0	2	0	0	0	0	0	0	2
Human Gene Therapy	0	0	0	0	0	0	1	0	1
Human Immunology	0	1	0	0	0	0	0	0	1
Hypertension	0	0	0	3	2	0	0	0	5
Hypertension Research	0	0	0	0	0	0	1	0	1
Immunity	4	0	2	0	0	0	0	0	6
Immunogenetics	0	0	1	0	0	0	0	0	1
Immunological Reviews	0	1	0	0	0	0	0	0	1
Immunology Letters	0	0	0	0	0	1	0	0	1
Immunology Research	0	1	0	0	0	0	0	0	1
Infection and Immunity	0	2	0	0	0	0	0	0	2
International Journal of Cancer	0	0	0	0	0	1	0	0	1
International Journal of Radiation Oncology Biology Physics	0	0	0	0	0	1	0	0	1

Table 3.13 (Continued)

Journal	RN HRM	RN Error	RN NR	RN NFI	CN HRM	CN Error	CN NFI	CN NR	Totals
Journal of American Chemical Society	0	0	6	0	0	0	0	0	6
Journal of Applied Physiology	1	0	0	0	0	0	0	0	1
Journal of Biological Chemistry	10	0	2	5	0	2	0	0	19
Journal of Bone and Mineral Research	1	0	0	0	0	0	0	0	1
Journal of Cell Biology	0	1	0	0	0	0	0	0	1
Journal of Clinical Investigation	1	0	0	0	0	1	0	0	2
Journal of Experimental Medicine	0	2	0	0	0	2	0	0	4
Journal of General Virology	1	0	0	0	0	0	0	0	1
Journal of Immunology	2	5	2	0	2	4	0	0	15
Journal of Infectious Diseases	0	0	0	0	1	0	0	0	1
Journal of Leukocyte Biology	1	0	0	0	0	0	0	0	1
Journal of Lipid Research	1	0	0	0	0	0	0	0	1
Journal of Molecular and Cellular Cardiology	0	0	0	1	0	0	0	0	1
Journal of Molecular Biology	0	0	1	0	0	0	0	0	1
Journal of Neurochemistry	1	0	0	0	0	0	0	0	1
Journal of Neuroimmunology	0	1	0	0	0	0	0	0	1
Journal of Neurophysiology	1	0	0	0	0	0	0	0	1
Journal of Neuroscience	1	0	0	0	0	0	0	0	1
Journal of Pathology	1	0	0	0	0	0	0	0	1
Journal of Pharmacology and Experimental Therapeutics	0	0	0	0	0	1	0	0	1
Journal of Trauma	0	3	0	0	0	3	0	0	6
Journal of Urology	2	0	0	0	0	0	0	0	2
Journal of Virology	0	0	0	0	0	5	0	0	5
Lancet	1	1	0	0	0	1	0	0	3

Table 3.13 (Continued)

Journal	RN HRM	RN Error	RN NR	RN NFI	CN HRM	CN Error	CN NFI	CN NR	Totals
Metabolism Clinical and Experimental	1	0	0	0	0	0	0	0	1
Molecular and Cellular Biology	1	4	0	0	0	1	0	1	7
Molecular Endocrinology	1	0	0	0	0	0	0	0	1
Molecular Pharmacology	0	0	0	0	0	1	0	0	1
Mutation Research/DNA Repair	1	1	0	0	0	0	0	0	2
Nature	1	1	0	0	0	1	0	0	3
Nature Cell Biology	1	0	1	0	0	1	0	0	3
Nature Genetics	0	1	0	0	1	0	0	0	2
Nature Medicine	0	1	0	0	0	0	0	0	1
Neurology	1	0	0	0	0	0	0	0	1
Neuron	0	0	1	0	0	0	0	0	1
New England Journal of Medicine	3	0	0	0	0	0	0	0	3
Obesity Research	0	0	0	0	1	0	0	0	1
Obstetrics and Gynecology	0	1	0	0	0	0	0	0	1
Oncogene	0	1	0	0	0	0	0	0	1
Oral Oncology	4	0	0	0	0	0	0	0	4
Plant Cell	1	0	0	0	0	0	0	0	1
PNAS	5	3	2	0	1	2	0	1	14
Science	3	0	3	0	0	1	0	0	7
Sleep	2	0	0	0	0	0	0	0	2
Transplant Immunity	0	2	0	0	0	0	0	0	2
Transplantation	0	8	0	0	0	0	0	0	8
Urology	1	0	0	0	0	0	0	0	1
Totals	**79**	**54**	**26**	**15**	**15**	**34**	**5**	**3**	**231**

Looking at the journal section heading for each retraction or correction notice, there were 39 different section headings for the notices. For the most part, the section heading directly related to the action taken (e.g., a correction notice under a "Corrections" heading of some type, a retraction notice under a "Retraction" notice of some type). However, 20 retraction notices were located under the section heading "Additions and Corrections" and 14 retraction notices were under "Corrections" or "Erratum". Under the heading of "Letters" or "Letters to the Editor", 12

retractions and 8 corrections were published. Under "Retractions" or similar headings, 12 correction notices involving partial retractions were published. No information on section headings was available for 12 retractions or corrections. Thus, roughly 34% of the notices published under section headings differed from the headings' indicated purpose. Table 4.14 shows the section headings for the notices published for all Subjects.

Table 3.14 Section Heading for Notices in Journals

ACTION	SECTION HEADING	# OF NOTICES PER GROUP
CN ERROR	Additions and Corrections	1
RN NFI	Additions and Corrections	1
RN NR	Additions and Corrections	7
RN HRM	Additions and Corrections	10
RN HRM	Announcement: Notice of Retraction	1
CN ERROR	Author's Correction	6
RN NR	Clarification and Retraction	1
CN NR	Correction	1
RN HRM	Correction	1
CN ERROR	Correction	5
RN HRM	Correction and Retractions: Retractions	1
CN ERROR	Corrections	6
RN HRM	Corrections and Amendments	1
CN P/R ERROR	Corrections and Retraction	1
RN ERROR	Corrections and Retraction	1
RN ERROR	Corrections and Retraction: Retraction	1
RN HRM	Corrections and Retraction: Retraction	1
CN P/R ERROR	Correspondence	1
RN ERROR	Corrigenda and Retraction: Retraction	1
CN ERROR	Corrigenda: Corrigendum	1
CN ERROR	Corrigendum	1
CN HRM	Corrigendum	1
CN P/R HRM	Corrigendum	3
CN AUTHOR NAME	Department of Error	1
CN P/R HRM	Erratum	1
RN HRM	Erratum	1

Table 3.14 (Continued)

ACTION	SECTION HEADING	# OF NOTICES PER GROUP
RN NFI	Erratum	1
RN NR	Erratum	1
RN ERROR	Erratum	2
CN ERROR	Erratum	5
CN HRM	Letter	1
RN HRM	Letter of Retraction	2
RN NR	Letter of Retraction	2
RN ERROR	Letter of Retraction	4
CN HRM	Letter to the Editor	1
RN HRM	Letter to the Editor	1
RN HRM	Letter to the Editor: Retraction of publication	1
RN ERROR	Letter: Retraction	1
RN NR	Letters	1
CN ERROR	Letters to Nature: Correction	1
CN HRM	Letters to the Editor	1
CN ERROR	Letters to the Editor	3
RN ERROR	Letters to the Editor	3
RN ERROR	Letters to the Editor: Retraction	1
RN HRM	Letters: Notice of Retraction	1
RN HRM	Letters: Retraction	2
RN NR	Letters: Retraction	2
CN ERROR	Letters: Sequence Correction	1
RN ERROR	NFI	2
CN NFI	NFI	4
RN NFI	NFI	6
NOC HRM	Note of Concern	1
RN ERROR	Notice of Retraction	1
RN HRM	Notice of Retraction	2
CN P/R NFI	Partial Retractions	1
CN P/R ERROR	Partial Retractions	2
RN NR	Retraction	1
CN P/R ERROR	Retraction	2
CN P/R NR	Retraction	2
RN HRM	Retraction	2
CN P/R HRM	Retraction	3
RN NFI	Retraction	5
RN NR	Retraction	9
RN ERROR	Retraction	68
RN ERROR	Retraction and Correction	1
RN HRM	Retraction and Correction: Retraction	1

Table 3.14 (Continued)

ACTION	SECTION HEADING	# OF NOTICES PER GROUP
CN P/R HRM	Retraction and Corrections: Retraction	1
RN NR	Retraction Notice	1
RN ERROR	Retraction Notice	3
RN HRM	Retraction Notice	5
RN HRM	Retraction Statement	1
CN P/R HRM	Retractions	1
RN NR	Retractions	1
RN ERROR	Retractions	2
RN HRM	Retractions	5

The 5-year impact factors and number of retraction and correction notices are shown in Table 3.15. The 5-year impact factors ranged from 52.426 (*New England Journal of Medicine*) to 1.286 (*Coronary Artery Disease*). Figures 3.8 through 3.10 show the relationship between the 5-year impact factor (IF) and total retraction and correct notices, IF and total retraction notices, and IF and retraction notices for HRM only, respectively. The Pearson correlative coefficient for each figure was 0.0119, 0.0182, and 0.0215, demonstrating limited correlative association between the two factors.

Table 3.15 Journal 5-year Impact Factor and Total RNs

Journal	IF	RN Totals
Coronary Artery Disease	1.286	1
Transplant Immunology	1.671	2
Biomedical Chromatography	1.695	1
International Journal of Radiation Oncology Biology Physics	2.009	1
Acta Obstetricia et Gynecologica Scandinavica	2.057	1
Cellular Immunology	2.14	1
Endocrinology	2.142	2
Urology	2.273	1
Immunology Letters	2.345	1
Current Opinion in Organ Transplantation	2.459	3
Immunogenetics	2.466	1

Table 3.15 (Continued)

Journal	IF	RN Totals
Biochemical and Biophysical Research Communications	2.474	4
Human Immunology	2.477	1
Current Opinion in Molecular Therapeutics	2.72	1
Hypertension Research	2.725	1
European Journal of Clinical Investigation	2.915	1
Genomics	2.917	1
Brain Research	2.957	3
Developmental Neuroscience	2.995	1
Metabolism Clinical and Experimental	3.008	1
Current Opinion in Investigational Drugs	3.01	1
Journal of Neuroimmunology	3.062	1
Diabetes and Metabolism	3.094	1
Biochemistry	3.104	3
Chemical Senses	3.142	1
Immunology Research	3.172	1
Journal of Trauma	3.204	6
Oral Oncology	3.41	4
Human Gene Therapy	3.435	1
Journal of Neurophysiology	3.446	1
Journal of General Virology	3.504	1
Transplantation	3.582	8
FEBS Letters	3.673	2
Mutation Research/DNA Repair	3.679	2
Journal of Molecular Biology	3.795	1
Developmental Biology	3.812	1
Genes, Chromosomes & Cancer	3.869	1
Journal of Urology	3.902	2
American Journal of Physiology: Cell Physiology	3.952	3
Journal of Pharmacology and Experimental Therapeutics	3.959	1
Fertility and Sterility	3.982	1
Journal of Neurochemistry	4.022	1
Infection and Immunity	4.096	2
Journal of Applied Physiology	4.193	1
Nature Cell Biology	4.295	3
American Journal of Physiology -Lung cellular and molecular physiology	4.338	1
Molecular Pharmacology	4.596	1
Journal of Leukocyte Biology	4.663	1
Molecular Endocrinology	4.715	1
Obstetrics and Gynecology	4.755	1
Journal of Virology	4.855	5
Journal of Biological Chemistry	4.863	19

Table 3.15 (Continued)

Journal	IF	RN Totals
American Journal of Physiology - Endocrinology and Metabolism	5.037	1
Journal of Molecular and Cellular Cardiology	5.133	1
American Journal of Pathology	5.205	1
Glia	5.374	1
Journal of Lipid Research	5.418	1
International Journal of Cancer	5.497	1
Journal of Immunology	5.57	15
Molecular and Cellular Biology	5.614	7
Carcinogenesis	5.815	1
Journal of Infectious Diseases	6.02	1
Sleep	6.229	2
Journal of Bone and Mineral Research	6.52	1
Journal of Pathology	7.224	1
Hypertension	7.346	5
Environmental Health Perspectives	7.607	1
Journal of Neuroscience	7.648	1
Oncogene	7.719	1
Clinical Cancer Research	8.101	2
Neurology	8.375	1
Cancer Research	8.958	1
Diabetes	9.105	1
Blood	9.609	3
EMBO Journal	10.168	4
Journal of Cell Biology	10.437	1
Plant Cell	10.656	1
PNAS	10.727	14
Circulation Research	10.759	2
Journal of American Chemical Society	11.015	6
Immunological Reviews	12.238	1
Genes & Development	12.765	1
Gastroenterology	12.951	1
Developmental Cell	13.012	1
Journal of Experimental Medicine	13.955	4
Journal of Clinical Investigation	14.449	2
Annals of Internal Medicine	16.482	1
Neuron	16.485	1
Immunity	20.948	6
Nature Medicine	26.501	1
Nature Genetics	32.138	2
Science	34.463	7
Cell	35.02	2
Lancet	39.315	3

Table 3.15 (Continued)

Journal	IF	RN Totals
Nature	40.783	3
New England Journal of Medicine	52.426	3

Looking at the Journals for the ORI-referenced articles that did not have retractions or corrections affiliated with them (Table 3.16), only *Molecular and Cellular Biology* and the *Lancet* had other ORI-related retractions or corrections. The *Lancet* had one RN HRM, one RN Error and one CN Error. The *Molecular and Cellular Biology* had one RN HRM, four RN Error, one CN Error, and one CN NR.

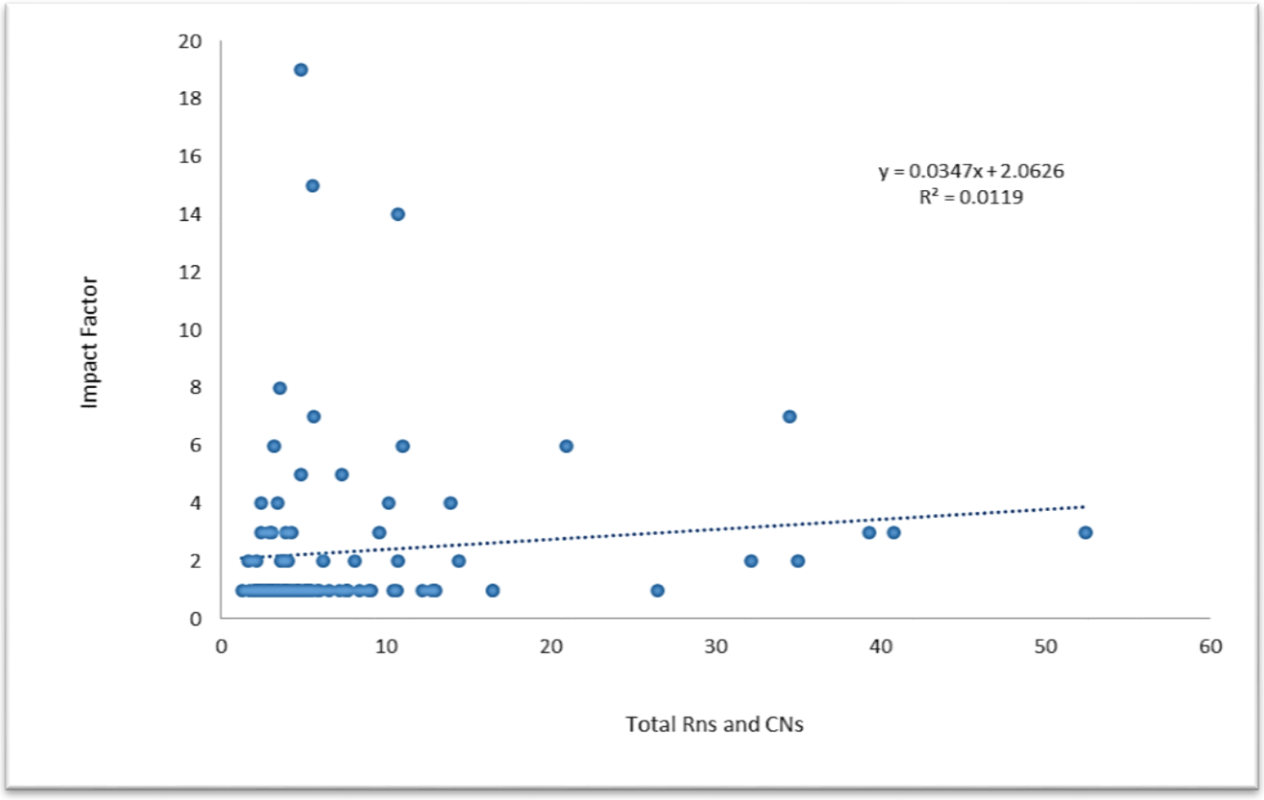

Figure 3.10 Impact Factors Compared to Total Retraction and Correction Notices

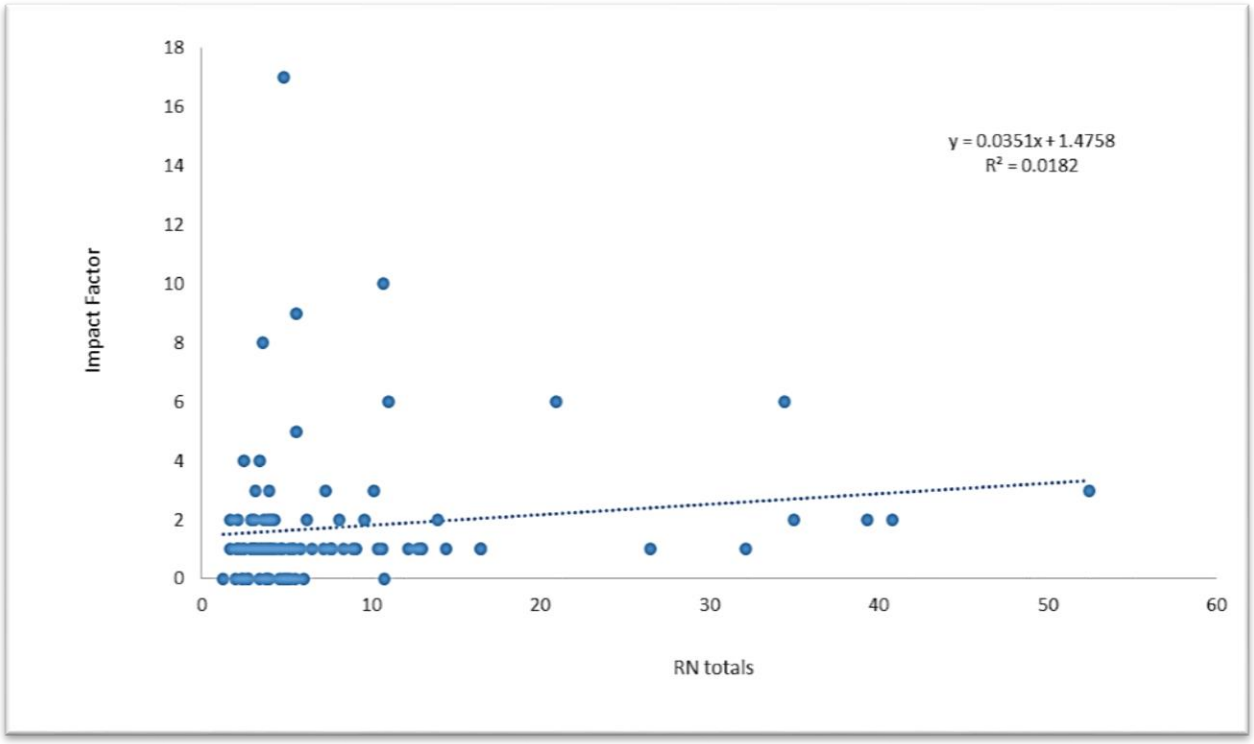

Figure 3.11 Impact Factors Compared to Total Retraction Notices

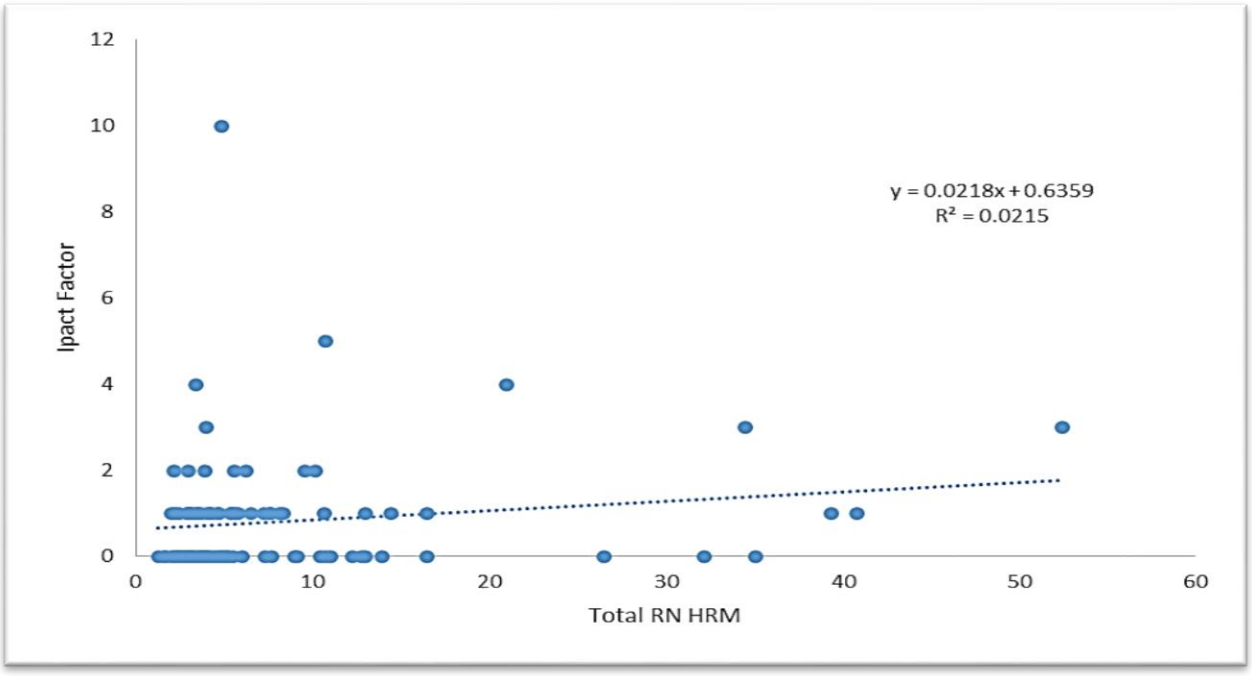

Figure 3.12 Impact Factors Compared to HRM Retraction Notices

A check of the Medline database showed that *Comparative Biochemistry and Physiology Part C, Molecular and Cellular Endocrinology, Proceedings of the Royal Society of London*, and *Shock* had errata (i.e., non-ORI misconduct findings) but no retractions listed. On the other hand, the *Lancet*, the *Journal of Clinical Immunology* and *Annals of the New York Academy of Sciences* had other (i.e., non-ORI misconduct findings) retraction notices in their archives. With such a limited sample, no significance can be assigned to the lack of ORI-related retractions.

Table 3.16 Journals referenced in ORI Findings with no RNs or CNs

Journals from Table 4.11	**Impact Factor**	**Number of ORI RN/CN located**
Shock	2.811	0
Comparative Biochemistry and Physiology. C: Comparative Pharmacology.	2.86	0
Journal of Clinical Immunology.	3.276	0
Annals of the New York Academy of Science	3.854	0
Molecular and Cellular Endocrinology	4.219	0
Molecular and Cellular Biology	5.614	7
Proceedings of the Royal Society of London	5.808	0
Lancet	39.315	3

No further assessment was performed on these articles in any subsequent counts of retractions or otherwise. With such a small sample and no applicable comparison set, statistical analysis was not likely to be meaningful.

CHAPTER FOUR:

DISCUSSION

4.1 Evaluation of Research Hypothesis

The crux of this study is the hypothesis that the number of retractions attributed to misconduct do not adequately convey the incidence of misconduct occurring in hard science research. Retraction studies repeatedly suggest that the rate of retractions is an adequate measure of the incidence of research misconduct, and that the low proportion of retractions to total articles indicate a minimal incidence of research misconduct. In this study of Subjects sanctioned for research misconduct, less than half (49.7%) of the Subjects had authorship on a published article stemming from the research in question and only 22.2% of the Subjects had an article with a retraction attributed to their research misconduct.

If retractions were a reasonable measure of research misconduct, one would expect that a majority of these Subjects, having a documented finding of research misconduct, would have a retraction attributed to misconduct. Instead, only small minority of Subjects had such retractions, while two Subjects had no retractions or even corrections at all, despite having authorship of ORI-referenced articles. Thirteen articles referenced as products of research misconduct had no associated retraction or correction notice, even though the ORI finding specifically addressed the six articles as requiring retraction or correction, or as already having such requests already submitted.

Including all retractions and corrections without regard to the verbiage assigning cause to the notice, the average notice per ORI-sanctioned Subject was 1.38 notices per Subject. The argument may therefore be that the overall numbers of retractions as located in general publication searches might be indicative of the overall number of researchers committing misconduct. This flawed reasoning is equivalent to the suggestion that of the $340,850,358 in property value stolen in robberies in the United States during 2012 (Meixell and Eisenbrey, 2014), each of the estimated 238,000,000 million adults living in the United States at that time (US Census Bureau. 2012) would have been responsible for a robbery of roughly $1.30. (My conscience and criminal record is quite clear.) Thus, the hypothesis that the use of retraction numbers is an inadequate measure of research misconduct incidence appears to hold true.

4.2 Evaluation of General Demographics

Retraction studies have also attempted to characterize researchers who commit misconduct by the information available within each retraction or correction. However, this study failed to show statistical strength in correlations between the number of retraction notices, with or without the inclusion of correction notices and educational level or positional responsibilities.

4.2.1 Education Level

A strong correlation between a Ph.D. and the number of misconduct-related retractions and corrections was expected, simply because the Ph.D. is generally considered as a research-related degree encompassing numerous publications, while MD or DVM might be more likely to engage in non-research practices only. While Ph.D.'s were disproportionately higher in the findings

(again, as would be expected by the very nature of the degree), the number of retractions and corrections showed no strong correlation to Ph.D. Subjects (Table 4.4).

Little, if any, meaning can be attached to this information. Educational status does not always correlate with job function or responsibilities, and no information was available to discern exactly what the relationship of the degree itself was to the misconduct incident. Unless one forwards the argument that graduate curriculum actually increases the likelihood of a student to commit fraudulent behavior or entices criminal aficionados, characterizing researchers based on degree alone is likely to be as misleading as counting the number of retractions themselves.

4.2.2 Professional Positions

The majority of ORI misconduct findings identified the position held by Subject at the time of the misconduct. In the findings that failed to provide some type of position title other than "employee", outside sources were searched for the professional title held by the Subject at that time. The span of responsibility identified in the misconduct findings extended from staff assistant to department director. More than two-thirds of the positions appeared to be associated with academic institutions, although some Subjects were associated with private industry or governmental regulatory agencies. Because ORI investigations are predicated on the involvement of NIH/PHS grants, assuming an association between the prevalence of misconduct and academic institutions is fundamentally flawed. Federal funding provides almost 70% of all academic research funding, of which the NIH is the largest funding source (NSB, 2012). Since private industry generally accounts for greatest proportion of funding for biomedical research (Dorsey et al., 2010), it is unlikely that they also would be proportionally represented in receipt of NIH

funding and consequentially proportionally subjected to ORI reviews of misconduct allegations and subsequent misconduct findings.

To complicate matters, and assuming the positon title within each ORI finding was accurate, the professional position title(s) held by each Subject at the time of the misconduct event must be considered distinct since each institution defines professional duties according to their own policies and procedures, making categorization by position title alone difficult. A "research assistant" at one institution might have considerably different responsibilities at a different institution, or the position duties may have changed substantially over a period of years. With this in mind, no attempt was made to assess the proportion of professional positions alone in the misconduct counts. However, a few important details stand out.

The position category of Technician included 16 Subjects (9.6%). These Subjects held positions unlikely to be directly involved in the production of a manuscript for publication or named as coauthor. Furthermore, they are also unlikely to be detected unless observed and reported by another, or when analysis results appear noticeably aberrant. A retraction is unlikely to present a "red flag" for other articles concerning such research in which the Subject was working unless an intensive investigation identifies a source. A researcher who suspects fraudulent work by institution technicians post-publication may retract an article; this retraction will not be representative of the number of persons who actually committed the misconduct unless the retraction provides such information. Information as to the total number of involved persons may not even be available at the time the retraction request is made. Marshall (2000) interviewed a scientist whose own research had been affected by misconduct. After one of the scientist's epidemiologists found anomalies in the data set, the scientist was able to identify an employee who fabricated interviews and other data in the early phases of the study. The researcher then worked

to validate all interview data gathered up to that point; "an epidemic of falsification" by employees permeated throughout the entire study's interview dataset. Diligence and an intense process of checks and rechecks was the only safeguard against publication of a fraud-laden research article. No retraction existed to serve as marker of this fraudulent behavior.

The importance of considering professional positon titles lies then in noting that misconduct findings have been made against broad spectrum of persons involved in all facets of research, lending credence to the concept that article retractions cannot indicate the breadth and depth of research misconduct. In short, anyone who works in a research-related role can and may commit research misconduct, regardless of potential authorship or manuscript contributory roles.

Reviewing the ORI misconduct findings uncovered a somewhat more disturbing implication. Although many of the position titles were prefaced by the term "former", this in no way indicated that the Subject no longer worked at the same institution, no longer worked in a research capacity or that professional advancement can be halted by a misconduct finding. Several Subjects have remained at the same institution in which they were employed at the time of the finding, and still others have changed institutions while still remaining in a research role. The assumption that institutional sanctions (ORI or otherwise), with or without retractions, may serve as sufficient determent for future misconduct does not seem to hold much strength. John C Hiserodt, debarred by ORI from participating in federally-funded research in 1994 for extensive falsification and fabrication, continued to participate, despite repeated admonishments from university officials, in such research at the University of California at Irvine until a 1997 investigation intervened (Blumenstyk, 1999). Paul Kornak received a lifetime debarment in 2006 after multiple episodes of fraud and misconduct up to 2002, some of which resulted in the death of at least one study subject, most of which occurred after a sanction was imposed in 1993. (Kornak

was convicted of criminal negligent homicide, as well as other criminal charges for his behavior.) Fortunately, repeated incidents as these appear to be rare, but may none-the-less indicate that fraudulent behavior may be more ingrained in the researcher than in the research environment.

4.3 Evaluation of Authorship and Journals Findings

The role of journal publishers and editors in the retraction of papers cannot by understated. Retraction notices are published at the discretion of the publishers and editors, who may or may not act in concurrence with the authors and/or investigating institution. Only 46 journals (46%) of the journals in this study published at least one retraction giving misconduct as cause. Of the 46 journals, three (*EMBO Journal*, *PNAS*, and the *Journal of Immunology*) also published correction notices with references to misconduct. Among the journals without any misconduct retractions, nine journals published correction notices with misconduct as cause. Hence, only 54% of the ORI-referenced journals, all editors of whom presumably having knowledge of an article within their publication containing fraudulent information since ORI investigations involving contact with the journals, chose to issue a misconduct-related retraction or correction. Only 40.6% of the ORI-referenced articles had misconduct-related retractions or corrections published, although it was the largest of the four categories of notices. Error (38.1%) was the second largest stated cause for a retraction or correction (keeping in mind that misconduct confirmed by an institutional investigation was the actual originating cause). Curiously, more corrections were issued for error than for misconduct, while more retractions were issued for misconduct than error. Without conversations with the journal editors, journal publishers, and article authors speculations as to this conundrum carries little weight. What remains clear, however, is that explanations as to cause for retraction or correction notice are about as likely to be as false as they are factual.

Understanding the cause for a retraction or correction has great significance to the general body of knowledge, and journal editors and publishers hold great influence as to how that body fares. However, not all editors seem cognizant of the issues of fraudulent research resulting in fraudulent articles. A survey of Wiley-Blackwell editors indicted that the majority did not consider issues of research ethics a major or frequent problem in their publications (Wager et al., 2009). The study authors acknowledged study weaknesses in that less than half the surveys were returned, but no indication was given in the study as to the journals retraction and correction rate and yearly article publishing numbers for each journal, which may have been a factor in their exposure to such problems. On the other hand, it is difficult to consider their lack of awareness of these issues, as more recent studies have indicated the problem as "disturbingly frequent" (Wager et al., 2009).

In describing case histories of rejected manuscripts, *Gut* editor Michael Farthing (1997) described what happened when he sent a rejection notice of a manuscript to both listed authors due to "fundamental flaws in the methods". The coauthor faxed him a response stating "he [the coauthor] had not seen the article, had not been involved in its preparation, and had not given consent to be a co-author" Farthing received an apology from the submitting author, "indicating an absence of knowledge regarding the conventions of not submitting a paper simultaneously to more than one journal and the requirements of authorship." Farthing did not provide an explanation for the disparity between the apology based on simultaneous submissions and the lack of coauthor knowledge of and involvement in manuscript preparation, nor did he indicate he sought one. Based on the immediacy of a fax and its content by the co-author, publishing protocols might not have been the central issue with the submitting author.

Editors and publishers may also lack the power to protect the knowledge body effectively. The absence of an official misconduct finding on the part of a government agency or academic

institution may cause hesitancy for publishers or editors to issue a misconduct-based retraction or correction for liability reasons (Resnik and Dinse, 2013). If misconduct is merely suspected, a journal may or may not have the financial wherewithal to hire sufficiently-skilled reviewers for data or image analysis. The case of the British Medical Journal (BMJ) and Dr. Ram B. Singh is a case in point.

As told by Carolyn White, BMJ's Press officer, BMJ spent over 10 years attempting to confirm research misconduct against one of its contributing authors (a Dr. Singh), but was unable to do so for lack of funds, time, and regulatory institutional support (White, 2005). According to White, BMJ attempted to build a collaboration with the American Journal of Cardiology (AJC) to investigate Dr. Singh's works, but AJC declined due to financial reasons.

Furthermore, unless any or all authors agree to comply with the sanctions in a misconduct finding, a journal can find themselves embroiled in a lengthy and therefore costly legal battle. Molecular Pharmacology stepped away from a notice of concern over fear of litigation. (Couzin and Unger, 2006). In the case of Joachim Boldt, whose fraudulent practices prompted a formal request from the State Medical Association of Rheinland-Pfalz (Germany) for the retraction of 88 articles from 18 journals, only 79 articles were actually retracted. Three journal publishers reportedly would not retract 6 of the articles due to legal threats from Boldt's attorneys (Elia et al., 2014). Clearly, without the assent of the author or extensive fiscal resources to obtain expert analysis and to withstand legal challenges, retraction or even correction of articles containing fabricated or falsified data is neither a simple nor guaranteed process.

Many retraction studies have theorized that researchers who commit misconduct are more likely to target higher impact journals than lower impact journals. Despite this much-advocated relationship, the Pearson correlation coefficient showed little association between the 5-year

impact factor and total retraction notices, total retractions and corrections, and total hard research misconduct-related retractions in the ORI misconduct findings. Proportionally the higher-impact factor journals were underrepresented in the IF data (23 journals with IF>10, 73 journals < 10), but it is unlikely that this would have masked the association to any large extent.

One significant weakness in the theory of higher impact factor journals being targeted by researchers who commit misconduct is in the retraction studies' datasets themselves, which is generally limited to the counts of retracted and/or corrected articles alone. A tracking of the total number of published articles (retracted, corrected and intact) per researcher per journal would be necessary to show any true relationship. If nothing else, the alleged higher number of misconduct retractions in higher impact journals speaks more to journal publishing policy than to author intent; the journals with higher impact factors may simply be more diligent in removing questionable articles than merely correcting them (Wager and Williams, 2011).

4.4 Public Health Implications

Preventing research misconduct is not merely an attempt to preserve the sanctity of the written word. Fraudulent research poses a distinct threat to the public's health and well-being, and the more often it reaches publication, the larger the threat it poses. The well-publicized surge in measles outbreaks in the United States stems in large part from Andrew Wakefield's fraudulent and subsequently retracted study linking autism to the MMR vaccination (Wakefield et al., 1998). Declared eradicated in the United States by 2000, measles outbreaks are increasing in frequency and have now been recorded in 27 states and the District of Columbia (CDC, 2015), because of the lack of vaccination by Wakefield's adoring, if not deluded, followers . The ORI-sanctioned researcher Paul Kornak was convicted of criminally negligent homicide for the death of one of his

study subjects; others were suspected but not proven. Novel oncology protocols, subsequently found to be invalid, were used to treat cancer patients based on now-retracted publications by former Duke researcher Anil Potti (Jha, 2012). Because of fraudulent publications on beta-blockers by Dr. Eric Poehlman, an estimated 162 out of 5254 trial participants may have died due to invalid trial treatment protocols based primarily on his research (Chopra et al, 2012). The concept of science as a self-correcting institution may yet remain true, but begs the question of at what cost to human life.

As this study showed, even using retractions themselves to discern which studies may be fraudulent limits the detection of actual fraud-embedded articles. There is a decided lack of standardization in journal retraction notices (Davis, 2012), and authors and editors alike may assign any number of reasons to a retraction or correction, regardless of originating cause. A proportion of the retraction or correction notices for articles in this study containing falsified or fabricated data or images used the excuse "failure to reproduce the study's findings" or some equivalent phrasing. Irreproducibility is a significant problem throughout biomedical sciences with some studies suggesting reproducibility rates as low as 25% (Prinz et al, 2011). Freedman et al (2015), basing their findings on a meta-analysis of 5 reproducibility studies, gave an estimated 53% irreproducibility rate with a cumulative direct cost of $28.2 billion in wasted research, and up to $1 million wasted in futile attempts to replicate the findings. Researchers at Amgen attempted to reproduce the findings of 53 clinical trials in oncology, and succeeded in only 6 of the trials – an 88.7% irreproducibility rate (Begley and Ellis, 2012). Authors Begley and Ellis point out the downstream risks – that further trials were conducted based on the non-reproducible studies "suggesting that many [cancer] patients had subjected themselves to a trial of a regimen or agent that probably won't work." Theories for the low reproducibility rates usually assigned poor

statistical power or analyses, or even errors made in the rush to publish; misconduct is rarely offered as a cause. Prinz et al (2011) found no correlation for reproducibility versus journal impact factor or number of articles, two factors retraction studies usually associated with misconduct. Likewise, this study of retractions directly resulting from fraudulent research showed no correlation for the same two factors, suggesting then that a study's "irreproducibility" commonly masks an underlying case of research misconduct.

4.5 Economics of Research Misconduct

Financial costs to research misconduct are almost as grave as the human cost. Michalek et al (2010) approached the analysis as a three part cost issue: the fraudulent research, the investigation and remediation. Total costs estimated for an actual case study of fabricating data and images in a federal grant application were over $538,000 in direct costs, roughly $40,000 in equipment and facilities maintenance, and roughly $1,200,000 in lost grants. Other costs were mentioned without specific quantification (such as costs of maintaining all records for the requisite 6 years from finding), but at a minimum a research misconduct case can accumulate direct and indirect costs exceeding $1,700,000 (Figure 4.1).

Research misconduct costs estimated by Stern et al (2014) are far more conservative. Costs to funding sources for each retracted article averaged $239,381.06 for all retracted journals and $361,905.44 for NIH-funded retracted articles, based on averaging of total NIH grant disbursements. However, the study authors acknowledged that the calculations do not include the downstream costs of the research misconduct, such as iatrogenic injury from treatment protocols developed from the fraudulent research. Omitted as well are the research costs when attempts to replicate these fraudulent findings fail as well as the costs of the investigation.

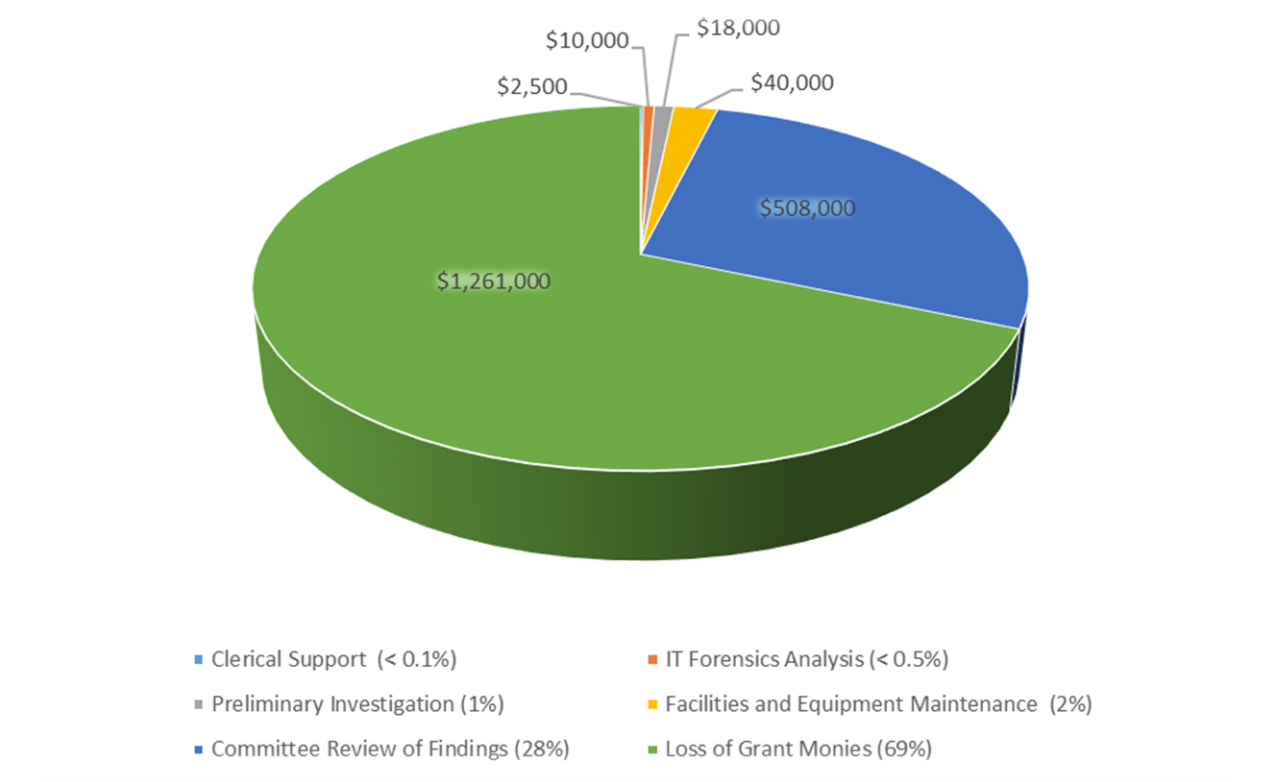

Figure 4.1 General Estimates of Costs of Research Misconduct (adapted from Michelek et al., 2010)

Gammon and Franzini (2013) divided research misconduct costs into four categories: investigative, grant award loss, voluntary exclusion agreement (ORI's settlement document) and retraction costs. Using 17 ORI misconduct investigation cases settled from 2000 to 2005, they calculated total costs ranging from $116,000 to $2,192,620, with median of $170,223.

Lacking in most if not all the economic studies are quantification of the litigation costs. University of Utah and University of California at San Diego were required to pay the Federal Government $1.6 million under the False Claims Act (Hilts, 1994). Duke University only recently settled lawsuits for undisclosed amounts to cancer trial patients, patient families and patient estates for the fraudulent research conducted by Anil Potti (Upchurch, 2015).

4.6 New Ways to Examine Research Misconduct

The weakness in using retractions as a means to gauge incidence or prevalence of research misconduct or even discern likely characteristics of researchers committing misconduct lies within the process of publication production itself. Consider the overall chain of events necessary into publish a retraction for an article produced from fraudulent research (Figure 4.2). Numerous steps allowing multiple interferences prevent the end variable (retractions for misconduct) to be a viable measure of the original variable (misconduct). Clinical trials, the proverbial "gold standard" of research where associations merge closer to causation, eliminate confounds and extraneous variables that may influence the dependent variable. No longer is it acceptable to judge the hypertension treatment successful by blood pressure measurement years or even months after a trial subject records eating oatmeal for breakfast. Yet, in essence, retraction studies are retrospective studies that do just that.

Reliable methods of determining research misconduct prior to manuscript publication are here-to-fore speculative. One researcher whose study was a victim of research misconduct said that the lesson he learned was to "validate the work yourself" (Marshall, 2000). For small studies, cross-validation by the principal investigator may be possible, but for large studies involving multi-centered research projects encompassing thousands of trial participants such safety measures are impractical and probably impossible. Furthermore, this throws the burden of research misconduct on the victim and not on the perpetrator, much like blaming a credit-card holder for fraudulent purchases made by a computer hacker.

Reliance on coworkers or subordinates to report misconduct potentially opens doors to malicious reports arising from illegitimate intentions. In defense of such reports, Price (1998a)

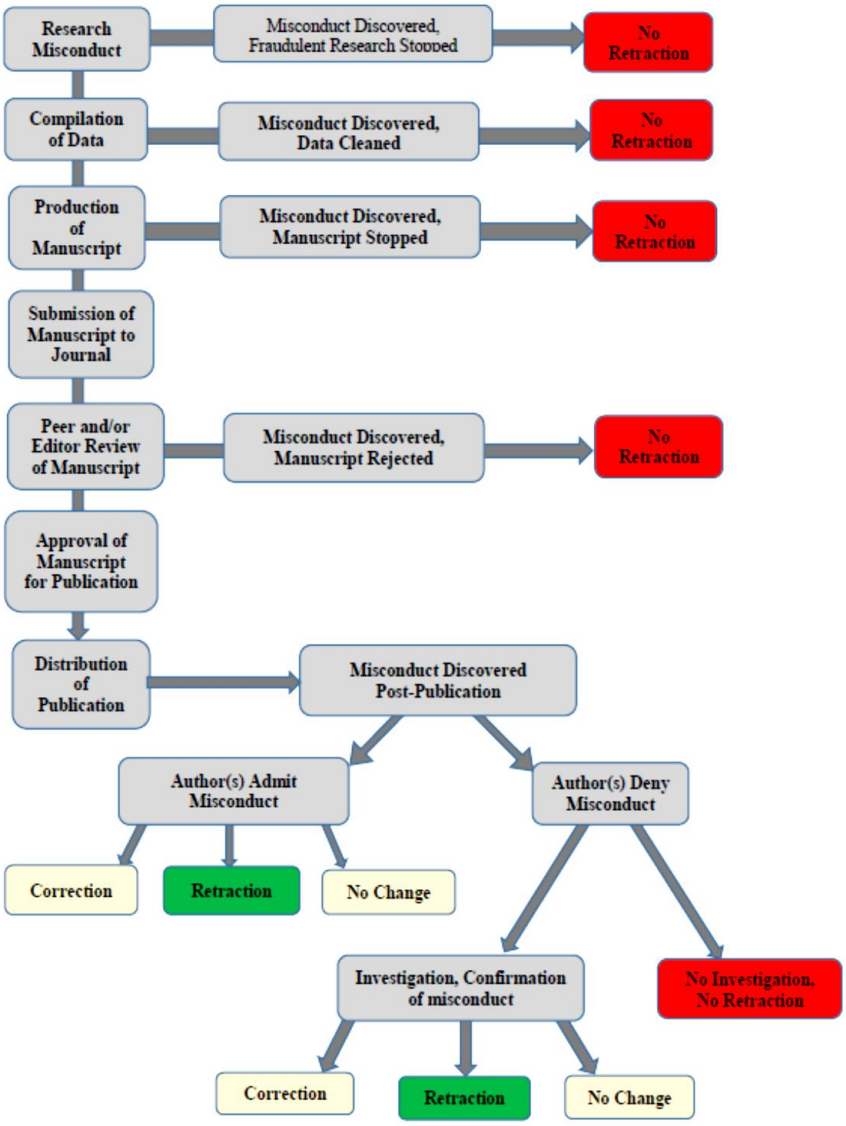

Figure 4.2 Flow Chart From Misconduct to Retraction

noted that only 8% of allegations received by the ORI from 1993 through 1997 were anonymous, suggesting that the majority of reports are traceable and thus less likely with abusive intent. Paola et al. (1998), from a survey of 119 deans of medicals schools, found that 56% of the deans reported having received anonymous letters casting aspersions on one or more faculty members, with over

half the deans initiating an investigation based on the letter, while the others either discarding it or merely filing it for recordkeeping. Paola et al. did not report whether the investigations validated the accusations in the letters or not, as the basis for the report was the concern over the acceptance of anonymous complaints. In a subsequent reply to a similar question by Price, Paola et al. (1998b) clarified that they did indeed find it preferable for recipients of anonymous allegations to "categorically discard" any report. However, it does seem possible that, contrary to Paola et al.'s intent, acceptance of anonymous letters as an impetus for investigations may serve an actual beneficial purpose more so than a detestable one.

Statistical measures to review data for fraud detection have also been suggested. Al-Marzouki, Evens et al. (2005) analyzed the data from two clinical trials using techniques such as "digit preference", i.e., the tendency of people to prefer certain numbers. Their analysis cast doubt on the randomization of the participants of one trial, which was already under suspicion for data manipulation. The underlying concept was that fabrication and falsification of data have inherent traits different to the randomness of natural error and typical to each person. With the advent of computer randomization programs however, this method may only detect those who use limited technological resources for falsification or fabrication. It does bear mention that the fraud of the Duke researcher Anil Potti was discovered by the statistical analyses performed by MD Anderson biostatisticians (The Economist, 2011).

In attempting to resolve the problems of research misconduct, the focus on retraction appears misdirected. Curbing retractions will not directly curb research misconduct and risks merely causing greater creativity in the creation of fraudulent research notebooks, instrument readouts, chemical assay solutions, peer-review systems, etc. Peer-review processes may actually be providing an avenue for fraudulent research articles. In one case, an author suspected of

misconduct repeatedly submitted manuscripts to journals – even the ones who were questioning his prior manuscripts (White, 2005). Quoting one of the investigators, White wrote, "Every time the errors on [his] manuscripts were pointed out, they were cleaned up for the next submission. So in effect the reviews were giving him a tutorial." Furthermore, over the last three years at least 110 retractions occurred from six separate fraudulent peer-review systems, where false identities and emails were created to allow fraudulent manuscripts to reach publication (Fountain, 2014; Ferguson, et al., 2014). A current publishing plague is referred to as "spoof" papers, where nonsense manuscripts are sent to journals as a test of the journals reviewing prowess. Over 120 papers were retracted from one journals after they were shown to be computer-generated, and not actual manuscripts based on actual research (Foley, 2014). The computer program to create the nonsense papers was developed by graduate students and is still freely available for use online at http://pdos.csail.mit.edu/scigen/.

Productive steps towards curbing research misconduct require adopting a new approach. Utilizing investigatory and profiling techniques from criminology may prove more successful than the past retraction studies (Furman et al., 2012; Hesselmann et al., 2014). A few studies have taken to looking more closely at the individuals who commit research misconduct in order to determine contributory factors. Redman et al (2006) examined the records of clinical staff subjected to ORI misconduct investigations and found managerial issues of work overload, lack of delegation and lack of authority to be common work environments in which these clinical staff work. Marshall (2000) interviewed a researcher whose own research had been affected by research misconduct. The researcher in question speculated that time pressures may have caused interviewers to fabricate data to meet deadline requirements. In a Nature article, Virpul Bhrigu offered an explanation for his sabotage of another researcher's work by saying, "I just got jealous of others

moving ahead and I wanted to slow them down" (Maher, 2010). Dong-Pyou Han, one of the few researchers ever criminally convicted regarding research misconduct events, assigned the beginnings of his massive fraudulent behavior to attempts to cover an error he made in samples years ago (Reardon, 2015). Suggestions of external pressures by industry and government agencies trying to drive policies in particular directions is also a speculative motive (Tong and Olsen, 2005), but there has been no credible research that conveys the extent to which this actually occurs, although realistically it cannot be discounted. Puigdomènech (2014) suggests that as money and promotion opportunities increased, so would incidents of research misconduct.

Other studies have suggested a motivation for research misconduct is the desire for publication in high impact journals or for the production of "a note-worthy paper" (Steen, 2014). However, while I performed no personal interviews with any of the Subjects for whom there is an ORI misconduct finding, it seems unlikely that the production of a published article would be the driving motivation for staff assistants or phlebotomists, whose names would be unlikely to appear on the article. This is not to say that the "publish or perish" axiom has no bearing on research misconduct; the spectrum of job roles imply a similar spectrum of motivations for involvement in research misconduct. A small percentage of economists in the European Economic Association admitted to sexual liaisons in exchange for research misconduct, publishing credit or promotional advantage (Necker, 2014). This data set is indeed limited and has more innate bias than broader studies on retractions over multiple journal categories. However, motivations for committing research misconduct would more likely be detected by looking at the person committing the misconduct rather than by studying retractions as an end result.

4.7 Study Limitations

All research studies have limitations, and this one is no different. The first and possibly most notable is the lack of cross-checks and data quality cross-checks as only one person performed all database searches, data input, and statistical analyses. Additional obvious limitations are the lack of print journal searches for retraction and corrections, a lack of determination of total publishing rates for each Subject, and assumptions of consistency of behavior between NIH-funded researchers and non-NIH-funded researchers.

CHAPTER FIVE:

SUMMARY

This study of retractions and corrections associated with ORI misconduct findings showed three important traits:

1. Misconduct in research is not always associated with the production of an article.

2. If an article is known to contain fraudulent data, it still may not be retracted. It may merely be corrected, or may not be amended at all.

3. Retraction and correction notices are more likely to contain incorrect information as to cause than to contain information assigning cause to misconduct.

If retractions are indeed a sound measure of the incidence of research misconduct, then research misconduct may proportionally be a limited occurrence. However, if research misconduct is, as suggested by this study, found to be more far-reaching than retractions convey, there is little likelihood that concentration on the statistical analysis of retractions is adequate for discerning the true incidence and prevalence of misconduct.

However, spending more resources attempting to quantify the rate of research misconduct seems unnecessary and wasteful. Very few problems as pervasive as unethical behavior (such as manifested by research misconduct) can begin to be resolved without a thorough understanding of the depth and breadth of the issues. Effective problem-solving requires one address the causative factors and focusing on retractions only misdirects the attention to the end result of misconduct.

Simply put, it comes down to choices. If the interest is in protecting the reputation and sanctity of biomedical and health-related journals, then by all means – pursue the interest in retractions, and throw in corrections as well. Improve pre-publication peer-reviews, insist on submission of data with the manuscript, have every author sign a form stating that the manuscript can be withdrawn, retracted or amended at the whim of the publisher or editor, and standardize language and notices of retraction and correction. Submissions will receive better scrutiny, better substantiation, less fuss from authors about retractions/corrections and easier discovery on searches for such information.

On the other hand, if reducing the incidence and prevalence of research misconduct, protecting public health, lowering risks of morbidity and mortality from fraudulent research, and conserving financial, equipment and manpower resources wasted on fraudulent research misconduct, then the time is now to move away from studies of retractions. Effort and resources should be invested instead in better oversight, division of labor and accountability, and discovery and investigation as to actual causes and indicators of research misconduct.

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