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Data-Sharing and Data-Withholding in the Genetics and the Life Sciences: Results of a National Survey of Technology Transfer Officers

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DATA-SHARING AND DATA-WITHHOLDING IN GENETICS AND THE LIFE SCIENCES: RESULTS OF A NATIONAL SURVEY OF TECHNOLOGY TRANSFER OFFICERS

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I. INTRODUCTION

Openness in data-sharing in academic research (defining data to include the full range of research results, including materials useful for future investigation) is regarded as a major ideal in the conduct of science. Merton described "communism" —the communal sharing of data and ideas—as a fundamental norm of the academic and scientific enterprise.[1] Though Mertonian norms are not universally accepted, the importance attached to the ideal of openness is illustrated by this quotation from Albert Einstein, which is inscribed at the base of his statue in front of the National Academy of Sciences: "The right to search for truth implies also a duty: one must not conceal any part of what one has recognized to be true."[2]

Recent evidence suggests, however, that in the daily practice of U.S. biomedical science, the powerful ideal of openness is often breached. Anecdotally, a number of instances of data-withholding have been reported in the press and scientific journals.[3] Additionally, a recent study of data-withholding reported that 47% of geneticists who asked other faculty for additional information, data or materials regarding published research reported that at least one of their requests had been denied in the preceding three years.[4] Ten percent of all *post*-publication

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1. ROBERT MERTON, SOCIAL THEORY AND SOCIAL STRUCTURE 610 (3d ed. 1968).

2. NAT'L ACADEMY OF SCIENCES, NAS BUILDING-THE EINSTEIN MEMORIAL, *at* http://www.nationalacademies.org/nas/nashome.nsf (last visited Jan. 30, 2003).

3. *See, e.g.*, Drummond Rennie & Veronica Yank, Editorial, *Disclosure to the Reader of Institutional Review Board Approval and Informed Consent*, 277 JAMA 922 (1997); Richard A. Knox, *Biomedical Results Often are Withheld: Study Examines Researchers' Financial Links to Corporations*, BOSTON GLOBE, April 16, 1997, at A1; Betty J. Dong et al., *Bioequivalence of Generic and Brand-name Levothyroxine Products in the Treatment of Hyperthyroidism*, 277 JAMA 1205 (1997); Ralph T. King, Jr., *Bitter Pill: How a Drug Firm Paid for University Study, Then Undermined It*, WALL ST. J., April 25, 1996, at A1; Jon Cohen, *Share and Share Alike Isn't Always the Rule in Science*, 268 SCI. 1715 (1995).

4. Eric G. Campbell et al., *Data Withholding in Academic Genetics: Evidence from a National Survey*, 287 JAMA 473, 477 (2002). Much of the foregoing article is based on this research conducted by the authors. The conclusions of the study were based on a survey of 1,849 geneticists and other life scientists in the 100 U.S. universities that received the most funding from National Institutes of Health (NIH) in 1998.

requests for additional information were denied.[5] Because they were denied access to data, information or materials, 28% of geneticists reported that they had been unable to confirm published research.[6] Twelve percent said that in the previous three years, they had denied another academician's request for data, information or materials concerning published results.[7] Among geneticists who said they had intentionally withheld information, data or material regarding their published work, 80% reported it required too much effort to produce the materials or information, 64% that they were protecting the ability of a graduate student, post-doctoral fellow or junior faculty member to publish, and 53% said they were protecting their own ability to publish.[8]

Such departures from the ideal of openness in science reflect the influence of powerful societal, institutional and individual motives. Government agencies (usually outside the life sciences) sometimes insist on secrecy in some publicly funded research to protect national security interests.[9] In the 1980s, federal policies also began to promote the commercialization of research through revisions in patent law and other statutes.[10] The purpose, to quote Abraham Lincoln's vivid rationale for the patent system, was to "add the fuel of interest to the fire of genius," and the result was an explosion of academic-industry relationships (AIRs) that created individual and institutional pressures to restrict sharing of scientific information.[11]

Studies of AIRs in the life sciences reveal that universities commonly grant industrial sponsors of research a period during which publication of results will be delayed, so that companies can review findings and secure rights to commercializable products.[12] Twenty percent of academic-industry research relationships reviewed by the NIH permitted industries to delay publication for longer than six months, and more than 80% of life science companies supporting research in universities reported in a recent survey[13] that their agreements

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5. *Id.*

6. *Id.* at 478.

7. *Id.* at 477.

8. *Id.* at 478.

9. *See generally* Peter M. Brody, *The First Amendment, Governmental Censorship, and Sponsored Research*, 19 J.C. & U.L. 199 (1993).

10. *See generally* NAT'L RES. COUNCIL, INTELLECTUAL PROPERTY RIGHTS AND RES. TOOLS IN MOLECULAR BIOLOGY (1997), *available at* http://www.nap.edu/readingroom/books/property (last visited Jan. 30, 2003); *see also* David Blumenthal, *Growing Pains for New Academic/Industry Relationships*, 13 HEALTH AFFAIRS 176 (1994) [hereinafter Blumenthal, *Growing Pains*].

11. Senator Abraham Lincoln, Address at the Young Men's Association of Bloomington, Illinois (Apr. 6, 1858), *available at* http://showcase.netins.net/web/creative/lincoln/education/patent.htm (last visited Mar. 5, 2003).

12. David Blumenthal et al., *Relationships Between Academic Institutions and Industry in the Life Sciences— An Industry Survey*, 334 NEW ENG. J. MED. 368, 371 (1996) [hereinafter Blumenthal et al., *Relationships Between Academic Institutions and Industry*].

13. *Id.*

sometimes require academic researchers to keep research results secret prior to filing a patent. Further, work by Blumenthal, Causino, and Campbell suggests that AIRs in genetics are both more prevalent than other fields, and more likely to involve restrictions on open communication.[14]

Previous work has demonstrated that AIRs may affect the tendency of academic scientists to share data with others or to withhold it in the hopes of protecting proprietary interests.[15] For example, when faculty patent the results of their research, or start a new company, they are more likely not only to delay publication of research results, but also to refuse informal requests from colleagues for access to scientific resources.[16]

Technology transfer officers (TTOs) stand at the interface of the industrial and academic worlds and oversee the transfer of technology from the academic to the commercial setting. In this role, TTOs observe and often participate in many of the ethical and normative issues surrounding academic-industry relations such as data-sharing and withholding. TTOs, for example, coordinate Materials Transfer Agreements (MTAs), oversee regulations in agreements between industry and academic scientists, and are responsible for the process of patenting and commercializing findings by faculty. Recent comments, however, suggest that TTOs are viewed as barriers to the transfer of information between academia and industry.[17] To date, we know very little about their unique perspective and experiences with data sharing and withholding in academic science. This study considers the attitudes and practices of TTOs an important factor in determining both the scope and impact of secrecy in the life sciences. Opposition to openness from TTOs could provide a significant barrier to sharing, even with the best intentions from academic and industrial scientists. In other words, TTOs are significant participants in the scientific conduct today. The purpose of this study was to shed light on the roles and views of TTOs with respect to data-sharing and withholding in genetics and the life sciences.

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14. David Blumenthal et al., *Academic-Industry Research Relationships in Genetics: A Field Apart*, 16 NATURE GENETICS 104, 106 (1997) [hereinafter Blumenthal, *Academic-Industry Research*].

15. Campbell et al., *supra* note 4, at 478; *see also* Blumenthal et al., *Relationships Between Academic Institutions and Industry*, *supra* note 12, at 371; David Blumenthal et al., *University-Industry Research Relationships in Biotechnology: Implications for the University*, 232 SCI. 1361, 1362 (1986) [hereinafter Blumenthal et al., *University-Industry Research*]; David Blumenthal et al., *Participation of Life-Science Faculty in Research Relationships with Industry*, 335 NEW ENG. J. MED 1734, 1737 (1996) [hereinafter Blumenthal et al., *Participation of Life-Science Faculty*].

16. *See* Campbell et al., *supra* note 4, at 478.

17. Hamilton Moses III et al., *Collaborating With Industry— Choices for the Academic Medical Center*, 347 NEW. ENG. J. MED. 1371, 1372 (2002).

II. METHODS

A. Sample

The data for this paper was obtained from a mailed survey of the senior TTOs at the 100 universities that received the most funding from the NIH in 1998.[18] Using the internet and institutional directories we identified all offices of technology transfer at each institution. When more than one office existed, we selected the technology transfer office that provided services to the medical school and/or the teaching hospital. We contacted each office by phone and identified the senior TTO (usually holding the title of director) in each of the selected offices.

The design of the survey instrument was informed by ten semi-structured interviews with knowledgeable TTOs, discussions with colleagues, and a review of the literature.[19] Several survey items were drawn from a previous faculty survey instrument, designed to measure the effects of data-sharing and withholding among faculty in the life sciences.[20] The survey instrument was informally pre-tested by asking several TTOs to review and comment on the instrument.

B. Survey Administration

The study and the survey instrument were approved by the Institutional Review Board at Massachusetts General Hospital, and the survey was administered by mail between September and November, 2001.[21] All subjects were sent a letter, a fact sheet describing the study, a survey instrument, a postage-paid return envelope, and a postage-paid postcard. Subjects were asked to complete the survey and mail the postcard separately from the completed survey. This process enabled us to track non-respondents via the postcard while assuring respondents complete anonymity since the survey instrument had no identifying information. Non-respondents were mailed a letter prompting them to answer the survey, and then were contacted by telephone and encouraged to participate. Of the potential 100 respondents, 79 valid questionnaires were received (an overall response rate of 79%).[22]

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18. The complete list of targeted TTOs and their respective universities is on file with the authors.

19. The timetable of interviews, discussions and review of literature was conducted in 2001.

20. See Campbell et al., *supra* note 4, at 476.

21. NIH, DATA-SHARING AND DATA-WITHHOLDING IN GENETICS AND THE LIFE SCIENCES: NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS (2001) (unpublished survey) (on file with the Journal of Health Care Law & Policy) [hereinafter NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS].

22. *Id.*

C. Variables

1. Measures of Office Activity

Respondents were asked to estimate the level of activity of their offices using several measures.[23] We asked for the number of full-time professional employees, the total budget for the most recent fiscal year, the total revenues from research-related payments, and the percentage of the revenues derived from activities in the life sciences and genetics.[24] Further, we measured office activity related to the life sciences during the previous year using various outputs of technology transfer, including the number of invention disclosures, MTAs, provisional patent applications, patent applications, patents granted, patents licensed, confidentiality agreements, and start-up companies.[25] Finally, we asked respondents to estimate how office activity in genetics had changed over the past five years compared with the rest of life sciences.[26] The categories were "increased very much more," "increased somewhat more," "been the same," "decreased somewhat more," and "decreased very much more."

2. Measures of Attitudes Towards Data-Sharing and Data-Withholding

Respondents were asked to rate the extent to which they agreed with the following statements: Academic scientists should:

> (a) Freely share information, data or materials with all other academic scientists prior to publication; (b) Freely share information, data or materials with all other academic scientists after publication; (c) Be more cautious when sharing with industry scientists than with other academics; (d) Be motivated only by the desire for knowledge and discovery, not by the possibility of personal gain; (e) Keep their newest findings secret to ensure priority in publishing; (f) Keep their newest findings secret to ensure priority in commercial application; (g) Receive some direct benefit (e.g., reciprocal sharing, monetary) from sharing information, data or materials; (h) Refrain from conducting classified research; (i) Refrain from participating in trade secrecy (defined as information that is kept secret to protect its commercial value); (j) Limit the involvement of students and post-docs in their commercial activities.[27]

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23. *Id.* at 1, 6.
24. *Id.* at 6.
25. *Id.* at 7.
26. *Id.*
27. NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS, *supra* note 21 at 5.

The response categories were "strongly agree," "agree," "disagree," and "strongly disagree." For analytic purposes we grouped the "strongly agree" and "agree" responses indicating agreement with the statement. We also grouped the "disagree," and "strongly disagree" responses indicating disagreement.[28]

3. Institutional Polices

We asked TTOs if their institutions have formal policies (including language that should be included in all grants and contracts) which prohibit researchers from conducting research that can never be published or publicly presented without the consent of the sponsor.[29] TTOs were also asked about the existence of policies that prohibit researchers from sending and receiving biomaterials without an approved MTA, policies that prohibit research agreements obligating delays of publication beyond the time required to file a patent, and policies that require researchers to submit an invention disclosure form to their institution prior to independently seeking to commercialize the results of their research.[30] When a policy existed we asked respondents to indicate the extent to which the policy was enforced.[31] The response categories were "very strictly," "somewhat strictly," "not very strictly," and "not at all."[32]

4. Impact of Withholding on Technology Transfer

Finally, respondents were asked to estimate how often, within the last year, the presentation or publication of research results by researchers in their institution had resulted in the denial of a foreign patent application, the denial of a U.S. patent application, the loss of an existing commercial partner, an inability to attract new commercial partners, the threat of a lawsuit, or an actual lawsuit.[33] The response categories were "never," "rarely," "often," and "very often."[34] For analytic purposes we grouped the "rarely," "often," and "very often" responses together indicating that an event had occurred at least once in the last year.

A second set of questions asked how often, in the last year, their offices were unable to negotiate an MTA with an academic institution, unable to negotiate an MTA with a non-academic institution, unable to grant a license, or unable to receive a license as a result of research sponsors' restrictions on the sharing of information, data, or materials.[35] The response categories, again, were "never,"

28. *Id.*
29. *Id.* at 2.
30. *Id.*
31. *Id.*
32. NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS, *supra* note 21, at 2.
33. *Id.* at 3.
34. *Id.*
35. *Id.* at 4.

"rarely," "often," and "very often."[36] For analytic purposes we grouped the "rarely," "often," and "very often" responses together indicating that an event had occurred at least once in the last year.

IV. RESULTS

A. Respondent and TTO's Office Characteristics

Table 1 shows the characteristics of the respondents. Almost three-quarters were male, 77%, had a Master's degree, and more than one-half, 64%, had either a doctoral or a law degree.[37] On average, our respondents had been in their current position for 4.6 years and working in the technology transfer field for nine years. Prior to working in technology transfer, almost one-half, 45%, spent more than five years conducting research in the life and health sciences, while one-third had no research experience in the sciences at all.

Table 2 presents several indicators of technology transfer activity in the past year. On average, the technology transfer offices surveyed had annual revenues of over $5.7 million, 77% of which was from the life sciences, and 20% from activities in genetics alone.[38] Also, respondents reported receiving an average of 66 invention disclosures on which they filed provisional patent applications on 31, and full patent applications on 35.[39] On average, the technology transfer offices in our survey were granted 22 patents, had 16.2 patents licensed, and had been responsible for 3.4 start-up companies in the past year.[40]

36. *Id.*
37. *See infra* Table 1.
38. *See infra* Table 2.
39. *See infra* Table 2.
40. *See infra* Table 2.

Table 1: Respondent Characteristics

		N	(%)	Mean
Gender:				
	Male	57	73	na
	Female	21	27	na
Degree:				
	Bachelor's	77	99	na
	Master's	54	77	na
	Doctoral or Law	49	64	na
Experience:				
	No research experience	26	33	na
	Research experience <=5 years	17	22	na
	Research experience >5 years	35	45	na
	#Years in field	79	na	9.1
	#Years in current position	79	na	4.6

We asked respondents to estimate the relative change in technology transfer activities in genetics compared to the rest of the life sciences.[41] On every measure of technology transfer reported in Table 1, TTOs reported a greater relative increase in activity in genetics compared to the other life sciences in the past five years. For example, over 71% reported a greater increase in the number of MTAs. Similarly, 63%, 55%, and 53% reported a relative increase in patent applications, patents granted, and patents licensed in genetics over the past five years, respectively.[42]

B. Attitudes Towards Data-Sharing and Data-Withholding

The bars in Figure 1 show TTOs' attitudes towards a set of statements regarding various aspects of the technology transfer process, data-sharing and withholding in academic science.[43] The bars to the right of the dotted line show the percentage of respondents who agree with a statement, while the bars to the left

41. *See* NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS, *supra* note 21, at 7.

42. Survey response sheets and tallied responses are on file with the authors.

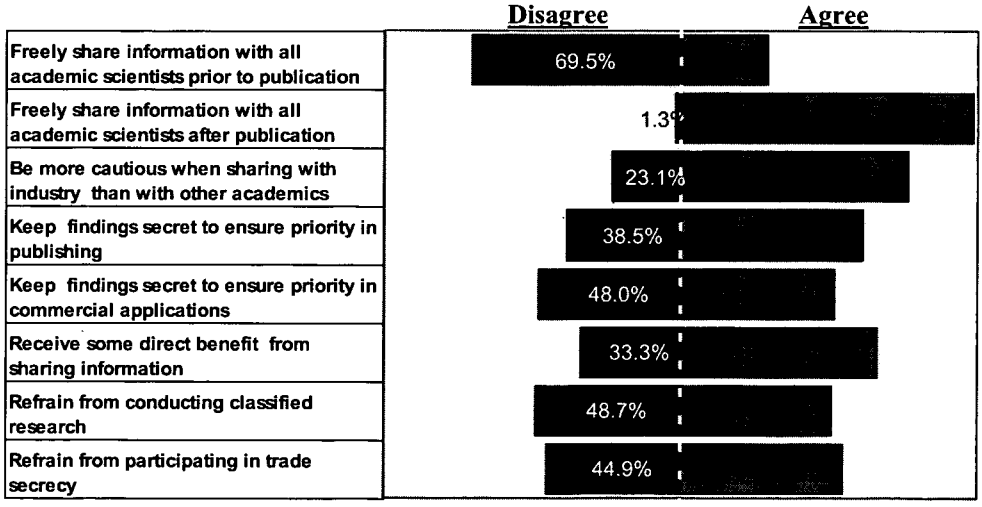
43. *See infra* Figure 1.

of the dotted line indicate the percentage of respondents who disagree with a statement.[44]

Table 2: Characteristics of Office Activity

	Mean
Full-time employees	5.1
Budget for the recent fiscal year	$1,200,410.00
Total Revenues	$5,792,700.00
% Revenues from life sciences	77.0
% Revenues from genetics	19.8
Invention disclosures	65.9
Material transfer agreements	194.4
Provisional patent applications	30.7
Patent applications	34.9
Patents granted	22.2
Patents licensed	16.2
Confidentiality agreement	88.2
Start-up company	3.4

Figure 1: Attitudes



44. *See supra* Figure 1.

Among TTOs there is almost unanimous agreement, 98.7%, that academic scientists should freely share data and information with other academic scientists after publication.[45] However, there is significant *disagreement* that such openness of sharing with other academic scientists should occur prior to publication: 30.5% agree and 69.5% disagree that scientists should share data and materials prior to publication.[46] Furthermore, about three-quarters, 77%, agree that academic scientists should be more cautious when sharing research information, data, and materials with industry scientists than with other academics, and two-thirds, 67%, of TTOs felt that academic scientists should receive something in return for sharing scientific resources.[47]

Respondents lacked consensus in their attitudes towards the other statements. There was a trend towards agreement with the statement that scientists should keep findings secret to ensure priority in publishing.[48] There was less agreement with respect to commercial activities: roughly one-half of respondents agree that scientists should keep new findings secret to ensure priority in commercial application.[49] Similarly, about one-half thought that academic scientists should not refrain from conducting classified research or participate in trade secrets.[50]

C. Institutional Policies and Policy Enforcement

As shown in Table 3, almost all respondents, 93%, reported that their institution had a formal policy that required investigators to file an invention disclosure prior to independently seeking to commercialize their research results.[51] Almost three-quarters of respondents, 72%, said their institution prohibited research from being conducted that cannot be published without the consent of the research sponsor.[52] About one-half of respondents claimed their institutions have policies that prohibit the receipt or sending of biomaterials (cell lines, tissue, sequences, reagents, etc.) to other scientists without a MTA.[53] A similar percentage, 47%, reported a policy that prohibited research agreements that delayed publication of research results beyond the time needed to file a patent.[54]

45. *Id.*
46. *Id.*
47. *Id.*
48. *Id.*.
49. *Id.*
50. *See supra* Figure 1.
51. *See infra* Table 3.
52. *Id.*.
53. *Id.*
54. *Id.*

Table 3: Institutional Policies

	%Yes	% Enforced *Very or somewhat strictly*	% Enforced *Not very or not at all strictly*
Does institution have policy to prohibit research that can never be published without sponsor consent?	72	98	2
Does institution have policy to prohibit receipt of biomaterials from other scientists without a MTA?	37	82	18
Does institution have policy to prohibit sending biomaterials to scientists without a MTA?	47	74	26
Does institution have policy to prohibit agreements that delay publications beyond time needed to file a patent?	47	100	0
Does institution have a policy to require invention disclosure prior to seeking independent commercialization?	93	93	7
Do any formal policies apply only to research in genetics?	0	-	-

We also asked if any of the above policies applied only to genetics.[55] In no case did respondents indicate that these or other institutional policies applied solely to data-sharing and withholding in genetics based research.[56]

All TTOs who reported that their institution had a policy that prohibited research agreements that delayed publication beyond the time needed to file a patent also indicated that this policy was strictly enforced.[57] Similarly, 98% reported strict enforcement of policies that prohibited faculty from conducting research that could never be published without the consent of the research sponsor.[58] Policies that required a MTA with the sending and receiving of biomaterials were less strictly enforced.[59]

55. *See supra* Table 3.
56. *Id.*
57. *Id.*
58. *Id.*
59. *Id.*

D. Negative Impact of Data-sharing and Data-withholding on the Technology TransferProcess

We asked the respondents to indicate if their institution had experienced a negative impact of publication on various aspects of the technology transfer process in the last year.[60] Virtually all respondents, 94%, indicated that they had had a foreign patent application denied because research outcomes were already published.[61] Slightly fewer, 82%, reported denial of a U.S. patent application for the same reason.[62] Seventy-one percent reported that they were unable to attract a commercial partner and one-half had lost an existing commercial partner because research outcomes were shared with the academic community via publication.[63] Also, 32% reported being threatened with a lawsuit as a result of publication, while 13% reported an actual lawsuit had occurred within the last year.[64]

Table 4: Negative Impact

	Experienced Impact at Least Once	
	(%)	(N)
In the past year, how often has the publication of research outcomes resulted in:		
Denial of foreign patent application	94	74
Denial of US patent application	82	65
Loss of existing commercial partner	50	39
Inability to attract new partner	71	55
Threat of a lawsuit	32	25
Actual lawsuit	13	10
In the past year, how often have sponsors' restrictions on data sharing resulted in:		
Failure to negotiate an MTA with another academic institution	46	36
Failure to negotiate an MTA with a non-academic institution	85	66
Failure to grant a license	48	38
Failure to receive a license	27	21

60. *See* NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS, *supra* note 21, at 3.
61. *See supra* Table 4.
62. *Id.*
63. *Id.*
64. *Id.*

We also asked about the negative impact of research sponsors' restrictions on the sharing of information, data and materials on technology transfer.[65] Forty six percent and 85%, respectively, indicated that sponsors' restrictions resulted in an inability to negotiate a MTA with another academic institution and another non-academic institution.[66] About one-half of respondents, or 48%, reported their institution was unable to grant a license to a company as a result of the research sponsors' restrictions on data-sharing and withholding.[67]

V. DISCUSSION

The data presented above represent the first systematic study of the attitudes and policies governing TTOs, especially from offices serving medical schools and hospitals. Several of the results presented above warrant discussion.

First, TTOs' attitudes towards data-sharing and withholding both before and after publication overwhelmingly support current practices in academic science in which periods of data-withholding are legitimized in order to ensure priority in publication— the primary mechanism by which scientists secure credit for their work and the coin of the realm of the reward system of academic science.[68] However, once published it is generally believed that scientific information, data, and materials included in the publication should be openly shared in the scientific community. This demonstrates that TTOs have been enculturated to academic scientific practices, which is not surprising since almost one-half of respondents had spent more than five years conducting research in the life sciences prior to serving as a TTO.[69]

Secondly, it is clear that the vast majority of TTOs believe academic scientists should be more careful when sharing research related information, data and materials with industry than with other academics.[70] Although we do not know the exact reasons for this concern, given that TTOs have considerable experience dealing with industry, it may be advisable for faculty to heed their advice when sharing research-related information, data and materials.

It is also interesting to note the *lack* of consensus in several attitudes towards data-sharing and withholding. Of the eight statements gauging TTO attitudes, four lack consensus (that is, there was no significant difference between the groups that agreed and disagreed with the statements). This reflects some of the conflicting pressures that shape the attitudes of TTOs. While the responses to some

65. *See* NAT'L SURVEY OF TECHNOLOGY TRANSFER OFFICERS, *supra* note 21, at 4.

66. *See supra* Table 4.

67. *Id.*

68. MARY FRANK FOX, *Publication Performance, and Reward in Science, in* HIGHER EDU. HANDBOOK OF THEORY AND RES. VOL. I (John C. Stuart, ed. 1985).

69. *See supra* Table 1.

70. *See supra* Figure 1.

statements show how TTOs have been enculturated to academic practices, attitudes towards other statements reflect concerns with facilitating technology transfer and commercialization of research. For example, respondents were evenly split when asked if academic scientists should be involved in classified research or trade secrets.[71] Some of these conflicting pressures described by TTOs reflect university-wide uncertainty with respect to secrecy.

Third, based on the reports of TTOs, some universities do *not* have policies designed to limit the amount of secrecy in academic science. Recall that under three-quarters of respondents, 72%, said their institution prohibited research from being conducted that cannot be published without the consent of the research sponsor, and less than half, 47%, reported a policy that prohibited research agreements that delayed publication of research results beyond the time needed to file a patent.[72] That is, over one-quarter of universities studied have no policies that limit research that can never be published or that may be delayed by a sponsor for long periods of time. These policies, when they exist, regulate secret academic conduct and may assist scientists that are facing the challenges of funding at the expense of open scientific behavior. And the absence of these policies suggest there maybe significant room for improvement in regulating data-withholding. However, additional research is needed to better understand the extent to which faculty are aware of, and obey, these policies, and what impact, if any, they have on the actual behavior of academic scientists.

Finally, our study suggests that data-sharing via publications has marked negative effects on the technology transfer activities of universities. For example, in the last year 50% of respondents reported that their institution had lost an existing commercial partner as a result of the publication of research outcomes.[73] Further, 12.7% reported that a publication by university researchers resulted in an actual lawsuit, which may be both costly and harmful to the public image of a university.[74]

Our study also illustrates some of the implications of data-sharing and withholding on research in genetics. As the results from the survey suggest, on virtually every measure of technology transfer (e.g., invention disclosures, patent applications, patents granted and licensees), the majority of respondents felt technology transfer activities had increased more in the field of genetics than in the other life sciences.[75] This suggests that TTOs increasingly confront data-withholding related to genetic research as a consequence of the recent rapid increase in commercial activity in genetics. As other published results in the field

71. *See supra* Figure 1.

72. *See supra* Table 3.

73. *See supra* Table 4.

74. *Id.*

75. Survey response sheets and tallied responses are on file with the authors.

suggests, genetics warrant special attention with respect to secrecy and data-withholding behavior.[76]

VI. STUDY LIMITATIONS

This study has several limitations that should be kept in mind. Like all survey data, ours is subject to biases resulting from non-response and under-reporting of behaviors that may be viewed as negative by respondents and their peers. Second, our survey was focused on research intensive universities and on the biomedical sciences. Data-sharing and withholding behaviors may display different prevalence and be influenced by different factors in less research-intensive environments and in different fields of investigation.

Despite this limitation, our study elucidates the significance and impact of data-sharing and withholding on the field of technology transfer. We have illustrated some of the conflicting attitudes, negative impacts, and policies that are driven by pressures from researchers, academic institutions and industry. Additional research can further clarify the negative impacts of publishing and sponsors' restrictions on technology transfer, and future policies should address those areas where current practices and attitudes thwart the progress and work of the technology transfer field.

76. Campbell et al., *supra* note 4, at 478.