Experimenting Outside the Information Center: Non-Traditional Roles for Information Professionals in Biomedical Research

Final Report

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Author Contribution Statement

Betsy Rolland and Emily J. Glenn planned and executed the study and contributed content to the report. Betsy Rolland wrote the final report. Both authors have reviewed and approved the final report.

Executive Summary

This report documents a thirteen-month research project, "Experimenting Outside the Information Center: Non-Traditional Roles for Information Professionals in Biomedical Research," which was conducted by the authors from January 2009 to March 2010 and funded by the Special Libraries Association (SLA) under its Research Grant program.

As biomedical research becomes increasingly complex and collaborative in nature, its information needs continue to grow. Several non-traditional roles for information professionals (IPs) have been established in an effort to support biomedical research, moving beyond the role of librarian as information researcher. In the highly competitive field of scientific research, librarians and information professionals[1] are poised to contribute significant skills to supporting and extending research teams. This study explored emerging roles for librarians in today's biomedical research teams in the hopes of providing support for the continued inclusion and expansion of opportunities for librarians.

We began with the following research questions:

1. In what aspects of collaborative biomedical research can traditional IP skills (as evidenced in the competencies statement) be applied in non-traditional ways?
2. How precisely are IPs applying those skills outside the role of librarian or traditional IP role?
3. How can the biomedical research process be improved by more targeted intervention by IPs?
4. How can SLA foster the development of non-traditional roles for IPs in collaborative biomedical research?

[1] The terms "Information Professional," "IP," and "librarian" are used interchangeably throughout this report.

Over the course of the past year, we spoke with 14 innovative, entrepreneurial information professionals working on diverse biomedical research teams across the country. The IPs who volunteered to take part in our study offered a wide array of services in support of the researchers in their institutions. Participants' jobs ranged from traditional library positions with non-traditional elements to bioinformatics specialists who did not perform any traditional library functions. We categorized the services participants offered into the following broad groups:

1. Original research and analysis, including in-depth literature searching
2. Bioinformatics support
3. Grant and manuscript writing support
4. Teaching and technical support
5. Traditional library services offered in non-traditional ways.

We found that participants had a deep understanding of the research environment, gleaned either from earned degrees in scientific fields or years of practical experience working with researchers. They utilized this understanding to devise innovative new services in response to the information challenges faced by scientists. All participants were engaged in substantial, crucial outreach efforts aimed at demonstrating their value to scientists around their institutions, relying heavily on referrals from satisfied clients to spread the word.

One of the most important outcomes of their increasing role on research teams is that librarians were being written into grants and contracts as staff members. The importance of this cannot be overstated, as it demonstrates that researchers recognized the value of the work performed by librarians and understood the advantage of including support for library services in the midst of a competitive grant environment.

While most participants did not participate in any type of formal evaluation of their services, all paid close attention to client satisfaction. Satisfaction was defined in a variety of ways, ranging from not receiving complaints to repeat business from clients.

Participants were frequently the only person at their institution offering cutting-edge services in the area of biomedical research and all felt isolated and without a professional "home." As a result, there is tremendous potential here for organizations such as SLA to step in and offer support for librarians in this rapidly growing and emerging field.

The most important take-away message from this study is that the involvement of information professionals is possible and desirable in all phases of biomedical research. Professional organizations can and should be doing more to support this community by providing increased access to affordable continuing education courses, more targeted conference programming, dynamic networking venues (online and offline), support of professional research and access to publishing opportunities in peer-reviewed journals.

Finally, our study generated many new questions surrounding the role of librarians in biomedical research. We propose three related areas for further study:

1. What more are librarians and libraries doing in the biomedical research field?
2. What is the real, measurable effect of offering these new services?
3. How can librarians be better supported by professional organizations, their managers and information schools in their quest to develop and offer innovative services?

1 Introduction

As two librarians involved in biomedical research, in two very different and non-traditional ways, we became intrigued with the question of whether there were others like us out there. Could it be just a coincidence that there were two of us within one mile of each other in Seattle? We didn't think so. At conferences and on listservs, we began to see others like us: information professionals (IPs) using their traditional library-based skills in non-traditional ways to support biomedical research. We met librarians employed in labs, research institutes, and universities who were meeting new information challenges. We proposed a study of this phenomenon to SLA as part of its Research Grants program, and this project was born.

1.1 Background

Biomedical research has changed dramatically in recent years. The information revolution has brought increased computing power, changing the questions scientists can ask. Communications technologies have made large-scale, distributed research possible. The subsequent explosion of information and data in science has created a whole host of new problems and, thus, new opportunities for the librarians who support them. (Witt 2008; Garritano and Carlson 2009) For librarians, these changes represent not only expanded professional opportunities but also the chance to increase their impact on biomedical research. Information professionals and librarians possess a unique set of skills such as analysis, research, needs assessment, and objective data gathering, skills which can mitigate some of the challenges faced by scientists.

As biomedical research becomes increasingly complex and collaborative in nature, the information needs of its researchers continue to grow. The technological and infrastructural challenges of collaboration – big science in a networked world – have been discussed in several forums in the library science community and beyond as *e-science*. Information services for a geographically dispersed workgroup such as a collaboratories are at the heart of e-science. (DeRoure, Jennings, and Shadbolt) Librarians' organization and information dissemination skills make them logical choices for teams involved in multidisciplinary and geographically dispersed research.

Several studies have been conducted to find out how information professionals can have a deep and lasting impact on scientific research groups by introducing new resources and providing related training as an accepted of part of the research team. (Robison, Ryan, and Cooper) One recurring conclusion is that the library must establish a presence in researchers' work environments, rather than expect researchers to seek out library resources and services. Whether designated as an intermediary or a project specialist, it is important for the information specialist to be engaged in the information culture of the research group – working in context – to develop a sustained partnership with researchers. (Rein)

In response to the changes in the way science is being done, many librarians have adapted their existing skill sets to craft new roles for themselves. They have created innovative solutions to aid researchers in organizing and accessing information. For example, the “biological information specialist” works in close collaboration with various discipline-specific research personnel on data management and integration. (Heidorn, Palmer, and Wright) Information managers coordinate the management of increasing amounts of research output.

(Hey 2006) Intelligence professionals combine scientific domain knowledge with business intelligence practices. (Berkein) At least ten potential new roles have been identified for information professionals associated with in-depth research such supporting evidence-based healthcare and systematic reviews. (Beverley, Booth, and Bath 2003) Many librarians are already involved in a variety of new roles in general biomedical research support as a result of their institution's membership in a national consortium of medical research institutions, funded through Clinical and Translational Science Awards (CTSA). (Rambo)

Many library and information science programs have begun responding to these changes. From certificates in bioinformatics to doctoral programs in information science, universities around the country seek to produce graduates with the skills today's biomedical researchers need. Several university-based programs in library and information science offer courses like public health or science searching, evidence-based medicine, or electronic health records alongside traditional courses in library science. Interdisciplinary combinations of courses may include computer science with a specialization in biotechnology or genomics, in biological sciences with a specialization in bioinformatics, or any combination of the above.[2]

Professional associations, too, have begun offering more continuing education classes and conference programming aimed at librarians in the biomedical research arena. Two recent sessions at the Medical Library Association 2010 conference, "The Informationist in Practice" symposium and a session called "E-science: Exploring the Librarian's Role," discuss the librarian's role in the advancement of e-science. (Walden) The upcoming SLA 2010 conference

[2] For a comprehensive list of programs, see Kampov-Polevoi, J., & Hemminger, B.M. (2010). "Survey of biomedical and health care informatics programs in the United States." Journal of the Medical Library Association **98**(2), 178-181.

will include sessions on evidence-based nursing, understanding the user perspective in a laboratory research environment and genetics resources. Recent conference programming of the American Society for Information Science & Technology included sessions on curricula in library and information science-focused bioinformatics programs, medical informatics theories and tools, and strategies for managing information across the sciences. (ASIS&T)

Librarians are now working as information leaders in environments where discovery, collaboration, tool development, data services, resource sharing, scholarly communication and funding are blended on a daily basis. This study explored emerging roles for information professionals in today's biomedical research teams in the hopes of providing support for the continued inclusion and expansion of opportunities for librarians

We began with the following research questions:

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2. How precisely are IPs applying those skills outside the role of librarian or traditional IP role?
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1.2 Methods

For this research study, we used a mixed methods design. To begin with, we utilized a grounded theory approach to understanding the process of performing information work in a biomedical research environment. We conducted a thorough literature review to gather information about the evolution of biomedical research and the nature of collaboration, while

exploring professional competencies of information professionals and non-traditional roles for librarians in science and other disciplines. This review also included a brief investigation of educational programs created for biomedical research information professional training. From this literature review, we developed a theory of how traditional competencies of an IP can be applied to biomedical research. We combined these competencies and our knowledge of biomedical research collaborations to develop a set of questions to ask during our interviews with our study participants (Appendix B). An institutional review board approved the research protocol.

Our next step was to identify information professionals serving in non-traditional roles on biomedical research teams. Our goal was to identify at least 10 IPs who met our criteria. We identified potential participants by sending out a series of recruitment emails to colleagues via email discussion lists of professional organizations and library and information science schools. The emails directed the individuals to view an information website for more information about the project. If interested in participating, the IP was instructed to click through to fill out a brief informational survey (Appendix A). Fifty-nine people completed the survey, though only 38 left valid contact information.

We then selected 26 survey respondents to screen for inclusion in the study based on their answers to our online survey. While we initially planned to phone screen only those respondents who had selected a minimum of three categories of daily tasks, we found that some of our respondents had selected just the “other” box and were doing tasks we hadn’t even considered.

In our initial screening of participants, we asked respondents which tasks they performed in support of biomedical research. The compiled responses are below. Note that these are responses from all respondents to our screening survey, not just from the 14 study participants.

Table 1
Survey Question Responses on Services Provided

Do you contribute to the work of biomedical researchers by providing services in any of the following areas? Check all that apply.		
Answer Options	**Response Percent**	**Response Count**
Instruction for local investigators using information resources developed by collaborators outside of your biomedical research setting	42.5%	17
Instruction for collaborators on using information resources developed by investigators in your biomedical research setting	27.5%	11
Project management	35.0%	14
Web-based portal management (including structure, metadata, workflow or information management for online collaboration spaces)	37.5%	15
Data coordination and presentation, including repository contributions and management of research output	25.0%	10
Remote support of external collaborators in any of the above activities	22.5%	9
Computer programming	12.5%	5
Knowledge management system to track personal contacts of investigators	7.5%	3
Knowledge management system to track research progress of investigators	7.5%	3
Scholarly communication or authorship support	47.5%	19
Dissemination of information to collaborators	42.5%	17
Support use of communication tools like web-based conferencing software	20.0%	8
Plan conferences or coordinate meetings for in-person interaction	35.0%	14
Search for relevant literature or information	72.5%	29
Taxonomy or ontology development	17.5%	7
User needs assessment	45.0%	18
Usability testing or engineering	27.5%	11
Other (please specify)		12
answered question		40

We spoke briefly with 25 potential participants. Conversations generally lasted 5-15 minutes and covered the respondent's primary job responsibilities. Based on this information and geographic location, we selected 17 IPs to interview for the study, later reduced to 14 because of three cancellations. Our respondents were quite geographically clustered, raising interesting questions of why some regions seemed more likely to have innovative IPs. Was it proximity to a top-tier information school, attachment to a prestigious medical school or simply coincidence? Because our sample was self-selected rather than representative, this is not a question we can answer with certainty.

After selecting our participants, we began the consent and scheduling processes, then traveled to meet our IPs in their work environments. We chose to travel to our participants instead of interviewing them in a telephone or web conference because of the value of face-to-face communications and our desire to see them working in their home environments.

Each IP who agreed to participate in this study was interviewed for about an hour utilizing an interview instrument we developed after completing our initial literature search (Appendix B). Our questions focused on what participants do in their positions, their role in their institution’s research and their thoughts and feelings about working as an IP in biomedical research. Our shortest interview was 34 minutes, while our longest was one hour and forty minutes. We followed the interview with a short “show and tell” session which allowed participants to demonstrate any interesting tools or projects they used in their work. Interview questions were not provided to the participant in advance of the interview.

After each interview, the authors reviewed their notes separately, then together and discussed the themes that had emerged. All interviews were transcribed by a hired

transcriptionist, then analyzed for patterns and themes. Once these themes had been identified, transcripts were reviewed again and coded.

1.3 Population

Most participants were employed by their institution's library and identified themselves as librarians, though this was not necessarily reflected in their official titles. One identified herself primarily as a bioinformaticist and did not have a library degree. Titles included[3]:

- Bioinformaticist
- Bioinformatics Librarian
- Clinical and Translational Sciences Librarian
- Health Sciences Librarian
- Librarian (2)
- Library and Communications Manager
- Medical Librarian
- Protocol Analyst
- Reference Librarian
- Research Informatics Coordinator
- Research Librarian

Ten participants had an undergraduate degree in a scientific field. As mentioned above, one of our participants did not have a library science degree, but the remaining 13 did. Two participants held doctoral degrees in life sciences. Two worked in small research institutes, ten in medical schools and two in research hospitals. Four participants reported to their institution's communications team, two were part of research teams outside of their institution's library, and the remaining eight were part of their institution's libraries. Years in the field of librarianship ranged from two to more than twenty. The number of people our participants supported in their work environments ranged from 37 onsite investigators and

[3] Three titles were removed or altered slightly, as they were specific enough to identify their holders, compromising anonymity.

their teams to several thousand potential clients across a large university. Some had specific departments to which they were assigned, while others were more general. One participant was a solo librarian; the others worked as part of teams ranging in size from two to more than fifteen.

1.4 Literature Review

The literature review began with a bibliography of 30 articles and other documents compiled by the authors in 2008. The initial bibliography was updated by searches in Library and Information Science Abstracts (ProQuest), Library Literature and Information Science (WilsonWeb), and Library, Information Science, and Technology Abstracts (EBSCO), MEDLINE, and by consulting resources included on the web sites of several professional organizations. The final compiled bibliography of 99 items reflects the interdisciplinary nature of the research question. It includes works on the following:

- information retrieval practices by scientists;
- the future of librarianship, transferable library science skills;
- career pathways to science, medical, and translational research librarianship, including clinical informationist and embedded librarian positions;
- formal and informal education programs for learning biomedical research domain knowledge;
- conference programming by professional organizations;
- educational programs for learning how to support the use of biomedical research databases and related resources from within a library setting;
- roadmaps, plans, and discussions of the infrastructure of next-generation science, science 2.0 and science 3.0;
- scientific research collaboration, virtual worlds, and relationships in a collaborative environment; and
- e-science and libraries.

The bibliography is presented as Appendix C.

1.5 Limitations of this Research

This research is an ethnographic study of a self-selected population and is not a representative sample. As such, our results are not generalizable. However, given the breadth of our recruitment efforts, we believe that we reached a large segment of the librarian population in the United States.

Our recruitment messages called for IPs working in "non-traditional" roles. In retrospect, it may have been useful to define that more clearly than "working in biomedical research in a capacity other than [as] a traditional information researcher" or more broadly to include more librarians. Several of our participants were surprised to find that they qualified for participation in our study, as they did not necessarily define their own work as non-traditional. It is possible that, had we defined our target population differently or simply used different terms that did not include "non-traditional," we would have found a different mix of services and roles.

2. Results

We found a rich and diverse spectrum of services being offered by librarians in a variety of biomedical institutions. In the course of collecting and analyzing the data, seven key themes emerged:

1. Services
2. Research Environment
3. Innovation
4. Outreach
5. Funding
6. Metrics and Success
7. Professional Identity

These themes, taken together, begin to create a picture of what it means to be a librarian in the fast-paced, rapidly evolving world of biomedical research.

2.1 Services

The positions held by participants encompassed a wide variety of responsibilities. While each position was unique, there was also a significant amount of overlap in duties. While no one participant offered all of the services detailed below, this list constitutes a possible universe of support for biomedical researchers. These services ranged from traditional reference to more novel bioinformatics support. It is important to note that these services represent what our participants chose to discuss with us. There are very likely additional services they offered which were not discussed, for whatever reason. It is likely that additional services are offered by the libraries in which they work but possibly not by participants themselves. We have left out the straightforward, traditional library tasks such as filling inter-

library loan requests and answering short reference questions, except in cases where participants performed these tasks in a non-traditional or innovative way.

Our participants' jobs ranged from traditional library positions with non-traditional elements to bioinformatics specialists who don't perform any traditional library functions. The services they provide reflect that vast diversity. We have categorized the services participants offered into the following broad groups:

1. Original research and analysis, including in-depth literature searching
2. Bioinformatics support
3. Grant and manuscript writing support
4. Teaching and technical support
5. Traditional library services offered in non-traditional ways.

2.1.1 Original research and analysis, including in-depth literature searching

"I consider any work where we're investing a significant portion of our time as research because that's what it is. I don't know how we ever got into that reference category. It must be some sort of a legacy thing." (P9) Whatever they call it, our participants spent huge chunks of time finding, compiling and analyzing information for their clients. While reference work and searching are traditional parts of a librarian's job, today's biomedical research librarians are extending their involvement more deeply into the research itself. No longer called upon to simply find articles for their users, our participants took it a step further by also offering analysis.

A driving factor behind this shift from *reference* to *research* and from *behind a desk* to *project team member* is the trend toward embedded librarians and librarians as core members

of research teams. Many participants were part of multi-year projects for which they were the designated librarians. The result is that the librarian got to know her team's information needs intimately, allowing her to contribute in a deeper way. Participant 2 was part of a team involved in ongoing systematic reviews. When asked about her relationship with that team, she noted, "there are two research associates that I almost work up their searches a little bit differently. I have a feeling for how many results they're willing to go through." (P2)

Several participants work in environments that have taken librarians off of the reference desk, replacing them with library technical staff who are able to answer the most common questions, like "How do I use the photocopier?" and "Where's the bathroom?" This frees librarians to answer more challenging questions and allows them to dig more deeply into research topics. One participant noted that the internet has made reference questions like "What is the sequence of *BRCA1*?" easy for users to answer themselves and helped pave the way for questions like "Given this genetic sequence, what other genes is that related to?" In short, she had moved from looking up facts in reference books to helping people synthesize those facts into new knowledge.

Participant 9 categorized all reference questions as research questions, making no distinction, partly because her organization no longer had a reference desk. "I like to call it research because that's what we're doing. We're not the same librarians we used to be. I used to get a lot of questions like, 'I need to know the relative base risk value scale for this particular [procedure].'" However, the questions have changed significantly, explained Participant 9, giving the example of a recent question she received: "I want to know what the impact is of a built environment on community health in urban populations." For these questions, said

Participant 9, there was no answer "that was going to be in some book where we could look it up." (P9) Instead, she utilized her own domain knowledge in public health to analyze relevant sources and her library science skills to compile and analyze the information required.

At least eight of our participants were involved with systematic review teams. Systematic reviews are searches of existing literature with the goal of determining the soundness of the published research. These reviews identify, appraise, select and synthesize all high quality research evidence relevant to a given question. For a review to be valid, search strategies must be implemented, tracked and published in the article. These searches are conducted by skilled researchers who have the knowledge of relevant databases, search construction techniques and training in the process of conducting these types of complicated reviews. A common thread among the participants involved in systematic reviews was their enthusiasm for a 2009 course at the University of Pittsburgh, *Supporting the Evidence: HSLS Systematic Review Workshop for Librarians*, taught by a group of librarians who had been involved with systematic reviews and realized librarians at other institutions could benefit from learning what they themselves had learned.

Participants also were doing a large amount of proactive searching for their researchers. This was most prevalent in the smaller research institutions or when librarians had fewer researchers they supported. When describing her job functions, Participant 3 told us, "…because we're a really small institution, I know everybody who works here and I know what their areas of research are, so I give them a lot of information proactively. It's not simply them requesting something and me providing. It's a lot of proactive work." (P3) Proactive selective

dissemination of literature search results was one way that librarians connected their clients with the information resources of the library.

2.1.2 Bioinformatics support

A few of our participants had moved deeply into the world of bioinformatics[4], with titles like "Bioinformaticist" and "Bioinformatics Librarian." These participants spent a significant portion of their time training researchers, including graduate students and post-doctoral fellows, on new tools and techniques for finding information about genetics and other biology-related questions. In addition to teaching courses, participants attended science classes to demonstrate tools to students, offered one-on-one training sessions on an as-needed basis and performed genetic searches for the researchers. These participants also were involved with groups around their institutions who were developing in-house bioinformatics tools. The tool developers had approached the library to ask for help with, among other things, development of taxonomies and usability testing.

2.1.3 Grant and manuscript writing support

Participants' time and effort are increasingly being written into sponsored research (i.e., grants and contracts), which will be discussed more thoroughly in Section 2.5, Funding. All told the same tale, in which an investigator, frequently a senior researcher, realized the value he was receiving from the library and wanted to justify more of the librarian's time than one research project could rightfully demand. This initial push generally grew out of a relationship that one or more librarians had developed with the investigator. As participants became more

[4] "Bioinformatics is conceptualizing biology in terms of macromolecules (in the sense of physical-chemistry) and then applying "informatics" techniques (derived from disciplines such as applied maths, computer science, and statistics) to understand and organize the information associated with these molecules, on a large-scale." (Luscombe)

involved with the grants themselves, they also became very involved with writing the grant proposals. As a member of the research team, they were expected to write scopes of work for their anticipated contribution, but also were often involved with the literature searching and grant development.

It follows, then, that participants are also more involved than ever in the resulting manuscripts. Several have been authors on papers produced by their research teams. Participant 3 also mentioned that, as an experienced librarian, she is frequently asked for advice on which journals are the best fit for a given manuscript.

Librarians were frequently asked to check and verify the references cited by researchers for both grants and manuscripts. For one librarian, this work led to a new position within her institution. Participant 13 was asked by the director of the research center to review a grant that the director was writing, specifically to check the references. Participant 13 went beyond that task and edited the document so well that she was asked to work on the organization's annual report. "[E]ventually, it just got to the point where she named me communications director because she wanted me to oversee the whole thing… It was just a fortuitous thing, just worked out." (P13)

2.1.4 Teaching and technical support

All participants taught classes, which ranged from information literacy courses to seminars on best practices for finding gene sequences in NCBI BLAST.[5] While this may be unique to our participants due to the nature of our study, our participants were primarily teaching classes about using software packages. The list of software is long and varied but

[5]Basic Local Alignment Search Tool (BLAST) finds regions of local similarity between sequences. It is resource of the National Center for Biotechnology Information.

invariably included bibliographic citation software, NCBI BLAST and other bioinformatics tools. Participants made efforts to engage learners and established a repertoire of courses that would be useful to their clients, despite the challenges of keeping up with the developments in such a rapidly changing field. Courses ranged from one-hour, brown-bag lunches to half-day workshops. One participant noted the difficulty of getting lab people into courses: "I have really tried to make more of a push to the shorter classes and more individualized instruction than the big, long classes because that gets to be a big investment for people. And it's hard to schedule a four-hour block because even if you theoretically could, people feel a lot of guilt for being out of the lab all afternoon..." (P7)

Classes were generally in-person but a few participants noted giving virtual classes. Participants also noted that they frequently do one-on-one training with participants and that this kind of training often follows a group class. For example, one student will have more specific questions than can be answered in a group session and will request a personal training. When asked, a few noted they are considering new ways of delivering course content, including podcasts and videos.

Sometimes training is less formal and is an outgrowth of a user coming to the librarian with a problem. "I have [students], who were so frustrated about looking for articles, assessing articles, and organize them and their instructors said, 'You need to use EndNote to organize,' and then they said, 'What is EndNote? How do you use it?' They are very, very afraid of that because it is [on the] computer. They said, 'Can I do this?' and then they came to me [with their] laptops and then we sat down for one or two hours and got them started—how to collect reference, how to organize reference, how to create groups, and then how to share with your

colleagues or your team members if you want to. They were just so happy. Because they are distance students so when they have time to come to campus, they just grab me..." (P6)

2.1.5 Traditional library services being offered in non-traditional ways

Offering traditional library services in innovative ways is another area where our participants demonstrate their unique roles. Our participants have made the shift to digital, online delivery of their services, while still valuing in-person and face-to-face communications. In short, participants favored digital when digital made more sense and in-person when it did not. "I'm definitely working on ways to put the library into the user's virtual environment, so instead of the library making this website and expecting people to come to the website, I think it's important to put the library into the virtual environments [where people spend time]. It's not even enough to create a mobile version of the library, it's not enough. I'm looking at ways – just like I insinuate myself in person, I'm looking for ways to insinuate the library in virtually." (P8)

Participants offered traditional services in non-traditional ways by blogging about new services and upcoming courses in addition to utilizing a more traditional newsletter or flyer approach, providing chat reference services, focusing on developing a mobile version of their online catalog and other tools. They compiled lists of appropriate new resources (articles, websites, tools) and distributed them electronically via email, blogs, wikis or whatever medium makes sense to their users.

Participant 6 was asked by a course instructor to create electronic subject guides and resource lists for her students. Over the past several years, the librarian and instructor have tried various technologies and found that wikis are a good choice for this work. Additionally,

this librarian creates "case studies" for the instructor's courses, pulling real cases from the literature, which the instructor then assigns to the students for analysis.

The digital age has made traditional copyright and intellectual property issues more pressing and more difficult to solve. Three of our participants had become the resident experts on these issues, working closely with their institution's legal departments to help define and enforce policies around the distribution of materials. "...[I]f anyone has questions about copyright or intellectual property or anything like that, I'm the go-to person. ... I set up this whole sheet of [P4's] policies on when [I] will and won't send you a PDF of an article and people were ... stunned that I took the time and energy to think through all of these different policies, but they were really glad …" (P4)

2.2 Research Environment

Our participants offered an amazing breadth of services to their researchers, seeking to add value at every stage of the research process. One of the keys to this level of service is having a deep understanding of the research environment. To be clear, this doesn't mean necessarily understanding the science behind the research itself but, rather, understanding the research process and how they can help. For a few, this was a result of having studied a scientific discipline at some point in their academic careers, but for others, it came simply from years of experience working with researchers in a biomedical setting.

Participant 4 noted that she utilizes her science background when thinking about her job. "...[W]hen I was in the informatics program and [earning] my biology degree, both [gave me] a real solid understanding of experimental design and study design, the [areas] where you can go wrong, the pitfalls and why you need to have a placebo control. And just enough

statistics to be dangerous…just enough to note, 'This seems kind of [odd], we better ask our statistician.' So having a firm grounding in the sort of research that we're critiquing is really helpful to me. It's less of a learning curve to say, 'We're critiquing these articles, what does this even mean?' but also … just the terminology and jargon and having an understanding of how biological research and clinical research happens is really helpful for this position." (P4)

When asked how they had developed such a high level of understanding of the research environment, participants mentioned a range of contributing experiences. Going to seminars and lab meetings was frequently mentioned as a way to immerse oneself in science. "...[W]hat I tried to do when I first started in the position was go to every single seminar possible. What were people interested in? Why were people bringing this to the seminars, or to this venue if it was an outside speaker? Who internally was presenting on what, so I could understand a little bit better what research was going on so I could see if the library could support that research in some way? So I went to those tools and technology seminars every week, even though I didn't understand all the stuff or what it was they were saying." (P9)

This knowledge of the research environment not only helped our participants do their jobs better, it also brought them closer to their users. As Participant 11 told us, she's always explicitly clear with her researchers that she's not a scientist. "I'm not coming in and saying, hey, I'm a PhD scientist, let's talk about this peer-to-peer. It's, you've got to explain this to me like I'm your mom, and then mom will try and find a way to [help] …I think that helps both of us because it gives me an understanding of what are the basic issues that are going on here, and what resources do I know of, that I can identify to help. But also, sometimes for them, I think approaching the problem in a different way makes it more clear what they need. I think my

understanding of how the labs work … has helped me to identify some points where I can be helpful where they wouldn't have even thought about it." (P11) At the same time, she's picked up enough of the scientific terminology over the past couple of years in her position that she can have an intelligent conversation and ask appropriate questions.

2.3 Innovation

From our first interview forward, we were struck by how innovative and entrepreneurial our participants were. Each one, in her own way, was assessing the landscape of her institution and looking for niches that needed filling. Each one had identified new services that could help investigators do better science. What was especially interesting about this was that there were a set of shared characteristics – environmental and personal – that were common to our most entrepreneurial participants.

First, all had supportive leadership that gave them great leeway in trying new things. Each one stressed that, if he approached his boss with a new idea for a new service or new way of doing things, he was routinely given the green light to give it a try. Several participants stressed that they were given vague job descriptions and told to make the job their own. "[My manager] does not have grand designs for us, so we're all more or less free to pursue the job the way we see it should be performed and it's just the right mix of people right now. So everything seems to get done. It works out pretty well." (P14) While initially intimidated, participants embraced the possibilities and were grateful for the freedom afforded them.

Second, our participants were not afraid of failing. Because this group is on the cutting edge of how biomedical research gets supported, there were bound to be failures, ideas that didn't pan out or new services that didn't get adopted. This didn't bother participants, as they

understood the old adage that it's better to fail than to never try at all. And their managers were savvy enough to ensure there were no penalties for the occasional failure. “I have a lot of freedom to try new things. I run things past my supervisor just to let him know, but for the most part, it’s always worth trying and if it works, then great, and if it doesn’t, then that’s fine too." (P7)

Third, all had mastered the art of the reference interview. To a person, each identified the reference interview as her most treasured skill from library school and expressed gratitude for having learned how to dig deeply into a person’s information request and identify the true need buried within. This is especially crucial in a developing field where both participants in the reference interview are treading new ground.

Finally, it seemed that our participants had really internalized the scientific method and understood that they, too, were in the midst of an experiment. The unprecedented growth in available information is stretching the boundaries of biomedical research and requires responses beyond traditional library services. Participants were comfortable trying new things, discarding them if they didn’t work and sharing their successes with others.

No matter what the new service or way of reaching clients might be, many of our participants made it very clear that they consider what they do to be traditional, core librarianship. All but the one non-librarian in the group identified as librarians and stressed that while the services and delivery methods may be new, what they are doing – supporting their clients – is not. "Librarianship isn’t changing that much, we’re just changing what we pay attention to. And it feels like we’re doing different stuff, but the core – the core of what we’re doing – isn’t really changing... You don’t need to feel scared or freaked out or worried about it

because it's the same stuff" (P10). They embraced the digital age, understanding that their clients' improving ability to find their own basic information such as relevant articles and simple facts opened up the door for librarians to offer new services.

Librarians recognized that the role of libraries will continue to evolve to support data. Participant 7 enthusiastically explained, "you see all of this information about data, free data movement and open access and shareware and different things like that—that's fantastic! I think the library can play a very big role in helping people to see what kinds of resources are out there, showing them how to use them, understanding and developing tools to help solve problems that don't exist already. Librarians are perfectly poised to be able to know and be able to find what exists.... I think it's a very exciting time." (P7)

Librarians continue to try to meet clients in the clients' space and provide the best ways to the best information. "You know the needs, you anticipate the needs, but between that, it's a gray—it's kind of space for you to jump. If you don't anticipate, you're always sitting there like the traditional librarian—you're sitting there, somebody comes to you and asks you a question ... you don't think about anything else, but right now, things have changed. You have to anticipate the needs." (P6)

This is an especially important point for librarians to consider. Many remain nervous about the future of librarianship and worried about tools like Google. What our participants have proven is that, for those with courage, supportive leadership and entrepreneurial spirit, the world is wide open and full of possibilities.

2.4 Outreach

Once we had established that our participants were, indeed, offering innovative and non-traditional services to their client bases, the question then arose, what were they doing to reach out to current and potential users to sell those services?

Why is outreach necessary? First and foremost, researchers are incredibly busy. Most scientists are juggling grant writing, supervising graduate students, teaching, participating in professional organizations and trying to find time to actually do their science. They have very little time to investigate new resources. Additionally, not that long ago, libraries primarily offered books and journals. The innovative services that our participants were offering are new and, perhaps, unexpected. Libraries have not traditionally been places where researchers could go for support of bioinformatics software, for example. Users don't know what they don't know, so to speak. Researchers may mistakenly believe that value-added services such as EndNote support or in-depth literature searching are fee-based services. Every library is different, offering different services. New faculty and students are not familiar with the library's offerings and may not take the time to investigate without a little push. Finally, asking for help is very difficult, especially for senior researchers. Things are changing rapidly and libraries are offering services for software and techniques that didn't exist five or ten years ago. Librarians need to reach out and build trust with their users and meet them where they live.

While each participant had his or her own unique twist on outreach, a few distinct set of techniques quickly emerged:

1. Developing a web presence, especially using Web 2.0 tools like blogs, wikis and social networking sites;

2. Attending faculty, departmental and lab meetings;
3. Word-of-mouth and taking advantage of existing connections;
4. Hallway conversations; and
5. Reference desk referrals.

Every library had a web presence, something that we take for granted now, but is still relatively new. The majority of our participants were involved in updating their library's website to some degree, either through producing content, architecting the structure of the site or developing the web interface. Most had also begun to experiment with some form of Web 2.0 tools such as blogs, wikis or social networking sites, which they used to communicate with clients about the library's services. One participant used a wiki page to detail her services and her qualifications, linking to this page in her email signature line. Several of our participants utilized blog software extensively to share new bioinformatics tools or interesting developments in the field with their users. "...I also write a biosciences blog. I post about once or twice a month, and I post items that are of interest to the research community, whether it be absolutely basic science research or translational science research. So I post items about new databases or updates, or…maybe other blogs that have really useful little tools that people can use, toolbars that they can install on Firefox, and things like that. ... I sign off on every one of those posts with links to my staff page at the library." (P12)

Blogs and electronic newsletters were also used by librarians to get the word out about themselves. "…[T]he library has a news blog and when I first started, there was a news blog item about me saying, 'I'm your basic sciences librarian.' ... And then about halfway through my fellowship, I contacted the relatively newly appointed dean of research, and I said, 'I know this

sounds weird, but I would like to be featured in the research newsletter.' And so they did an interview with me for the research newsletter, and a couple of things have come about as a result of that." (P12)

Attending meetings was a recurring theme and an interesting complement to the online presence. Time and again, our participants noted that there is no substitute for face-to-face contact and personal connections. Several told stories of talking their way into departmental or faculty meetings, despite protests or bemusement of the attendees, then being asked to come back again and again because of their valuable contributions. Participant 9 once attended a departmental meeting, where she had a 10-minute timeslot to discuss bioinformatics tools. After 30 minutes of fielding rapid-fire questions from attendees, she apologized for monopolizing the meeting and tried to leave, but was asked to stay longer.

Participant 4 found this meeting-attendance approach particularly successful. She was asked to attend one meeting and help with one small part of a project; namely, reviewing a search strategy for the team. She found the project and the meetings so interesting that she continued to attend, even after her part of the project had ended, and continued to find ways that she could contribute, ways the project team had never even considered. This work and the contacts she made on this project eventually led to her current position.

> "That's the same advice that Pittsburgh [seminar] people have for the librarians: just be pushy, value your contributions, and be specialized in service sort of like biostatisticians. Nobody does their own statistics. They get a statistician to come in and [charge their] time and listen to them and do the [work]. And similarly, every team … would benefit from having a librarian on it. There are lots and lots of instances where if you can just get yourself in there and not leave, eventually the group realizes how valuable librarians are. ...I've heard this over and over again from non-librarians who I've worked with who [tell me], 'First I couldn't quite understand why we had you on this team and on this project, [but] you were invaluable.' Sometimes you just have to stick it out through the long haul." (P4)

Attending meetings also makes connections that may later turn into word-of-mouth referrals. By making these initial connections and subsequently proving their value, our participants gained credibility with other researchers. Speaking about one strong connection with a lab manager, Participant 11 noted, "... that relationship, in turn, has opened up other doors because he's the manager for the lab for the head of the cancer center... What I've found is... I can contact people all day long, and who am I? But if somebody else, says, hey, she helped me with this, it helps to be able to go to other people and say, 'any chance you're having a problem like the one that my friend, Steve, over in such and such a lab is having?'" (P11) Relationships are paramount in academia; having a connection makes breaking in that much easier.

Both Participant 3 and Participant 12 depend heavily on hallway, or "water-cooler," discussions. Participant 12 notes, "[my supervisor] really believes the hallway encounters or the little personal seminar encounters are a really good way to make a few strong contacts, and they really are. And I feel like sometimes that it helps you kind of get a foot in the door for being invited to more faculty meetings and departmental things." (P12) Such informal discussions, as well as coffee and lunch dates, allow librarians to get to know their clients and their research interests better, leading to the potential for better service.

When asked to quantify the effects of her outreach efforts, Participant 8 responded, "in my experience, I think those outreach efforts probably produce 70% of the traffic, but that's all of them combined, that's showing up, getting invited to meetings. You can't forget the virtual reaching out either." (P8)

2.5 Funding

One unanticipated theme that emerged quickly in our interviews was that of funding. As we began talking to our participants, it quickly became clear that librarians were increasingly being written into funded research as project staff members in addition to being funded by institutional overhead dollars. We think that this indicates a major shift in how scientists, particularly principal investigators who initiate research proposals, think about librarians.

In order to understand the full significance of this shift, it is important to understand the climate of biomedical research. Scientists at most research institutions are responsible for generating much or all of their funding through sponsored research (i.e., grants and contracts). Only work that supports and furthers the scientific objectives of a project may be written into and funded by a grant. Efforts are made to only include things that (a) are scientifically and organizationally necessary and (b) make the proposal stronger and more competitive. That scientists are both willing to spend precious grant dollars on information support services and understand that librarians make their research work and projects more competitive is of huge significance. Securing a major grant can make a scientist's career. Research has shown that the more funding a scientist has, the more he gets. (Ippolito et al. 2005)

One potential downside of this apparent increase in direct funding of library services is that grant dollars, which fund a portion of a librarian's time and allow him to spend a greater portion of his time on a given project, come and go and are less stable than funding from the institution. In these uncertain economic times, however, when universities are slashing administrative budgets, this direct funding could be the only thing that keeps libraries viable.

The libraries of two participants were actually adding staff, despite institution-wide cutbacks, thanks entirely to staff members being written into grants.

Being written into grants transforms librarians from static service providers, sitting behind a reference desk and answering individual questions, to integral members of a project, on par with the scientific staff. By reserving the time of librarians for their projects, investigators are including librarians in their staff headcount, as they do with statisticians, laboratory staff and others.

Several of the librarians we interviewed had also written their own grants to study aspects of their libraries or provide new services to their researchers. It's a difficult space for writing grants, however, as the projects librarians would like to pursue do not always fit neatly into funding agency priorities. It seems that funding agencies have not necessarily kept up with the changing nature of biomedical research. Most librarians do not have PhDs, making it difficult to act as the Principal Investigator (PI) on a National Institutes of Health or National Science Foundation grant. Participant 9 reported finding it very difficult to find a PhD-level investigator for a project because most investigators are so busy. Even volunteering to write the entire grant did not work, because she still needed the scientist to write the methods section.

It would seem that this would be an area where the National Library of Medicine could help: making grants available for Masters-level, experienced librarians to write grants to do library-based, professional research. While NIH grants are theoretically open to anyone with the requisite skills to perform the research, in practice, it is unclear if research by Masters-level librarians is ever funded. The effect on biomedical research of librarians doing research could

be profound, as librarians could develop evidence-based practices around meeting the information needs of researchers, making scientific research more efficient and generating greater return on a funding agency's investment.

2.6 Metrics and Success

One question of great interest to us was that of defining success. As librarians are increasingly asked to justify their existence in a world of online resources and Google, it is crucial that we are able to prove our value and have anecdotal evidence of success ready at a moment's notice. Collecting such stories of satisfied customers and value-added services leaves us prepared to respond quickly and decisively to a decision-maker's demands. Additionally, while the *quantity* of scholarly output is often used to measure a researcher's success or impact on a field, the same metrics are usually not as prevalent for librarians. So, how do librarians define success for themselves in their positions and with their clients?

When asked, participants consistently defined success as positive recognition of their work by clients. When they knew that a client was satisfied, participants felt assured that they had done a good job. This satisfaction was gauged a variety of ways, from direct acknowledgement and praise to the absence of any complaint. Aside from the requisite "thank you," most of our participants reported receiving very little feedback from their clients, which most took as a good sign. "I don't get a ton of feedback. I don't get any complaints, so that's always good. I guess I do get comments, '[You] can find anything' or those kinds of things which are nice to hear. I feel like people value my skills and they do seek my advice." (P3) One participant mentioned feeling like she is doing a good job if she is busy and people continue to seek her help.

Very few participants were involved in formal evaluation programs. Most felt that their users were too busy or "surveyed-out" to participate in such a program. This was despite their understanding that such formal quantification of success could be useful. For our participants, it boils down to: “Are we meeting the needs of our users?” which is a tricky thing to measure. One option several participants mentioned was focusing on user needs assessment, something librarians are trained to do. Rather than assessing whether or not they were doing a good job with the services they do offer, they were thinking about whether or not they are offering the right services. Participants repeatedly mentioned that they had to learn the culture of the research environment and figure out what would be most useful to researchers and at what points in the research process.

Two participants also mentioned having advisory committees comprised of external stakeholders. The relationships described were very cooperative, rather than combative as can sometimes be the case with external stakeholders. The impression these participants gave was of gratitude for having a group of smart, well-placed champions who were interested in the future of the library and ensuring it met the community's needs.

While what constitutes success in this field may be difficult to define, it clearly requires surmounting substantial challenges. First and foremost, for many, their user base is vast. One participant, a librarian at a major medical school, told us, "[Our library staff is] really small, and even though it’s a big library, our reference staff is really about three-and-a-half or four FTEs [full-time staff], and if you add up all the people, all the faculty and all the graduate students, it’s like 14,000 people that are supposed to be [supported]." (P14) Some rarely see the faculty members themselves but work closely with the graduate students and post-doctoral fellows

employed by the investigators. This degree of separation and the transient nature of students can make it even more difficult both to assess satisfaction and to gain inroads into the community.

A second major challenge our participants faced is the sheer volume of published scientific information and the rapid pace of the science behind it. Even Participant 9, who had been a biology major and pre-med student in her undergraduate days, hardly understood the language her bioinformatics clients were speaking when she took her current position. To catch up during her first few months on the job, she spent hours on Wikipedia, studied recent textbooks and scanned articles in journals.

We asked one of our participants if she felt she was having an impact on the research she supported.

> "I think that I save people a lot of time, because I find the resources they need to support their grant applications. I teach them how to organize those resources with citation management stuff and most of them have no idea how to use that stuff. I know for a fact that I've had a strong impact on nurse researchers—giving them more confidence in how they search the literature, watching them go from thinking, 'I don't know how to do anything on computers' to coming to me all proud and saying, 'I did my literature search and I got all of my articles all by myself.' So the confidence I've been able to give people I think is a big deal too. ... I think that the work they do is better informed, … I think that I've had an impact on defining for them what evidence-based practice and what evidence-based medicine actually is. I've given them a way to sincerely practice that, not just use the words." (P8)

For some participants, achieving co-authorship with clients was a sign of successful integration with a research team. "[S]ome of the work that's come out has been so exciting. I've been able to publish two papers with [a researcher's] group, which is great. This is my first time in PubMed, I can look my name up, yea! I'm like author number seven, somewhere embedded in the thing, which has been really great." (P9)

While authorship was noted as a success, librarians were also aware that without advocating for themselves, they might not be included on the research papers of their clients. One participant was inspired to become her own advocate for professional recognition. During a CE course for librarians who conduct systematic reviews, course leaders encouraged librarians to demand to be identified as authors, particularly for work on complicated searches for systematic reviews. According to Participant 4, if you "wrote the methods section about the search, you are an author." (P4)

Participants also sought to contribute to the knowledge base of their clients. Participant 4 will be publishing an article on expert searching in a major scientific journal, contributing to the literature used by her clients and showcasing her own talents as a librarian research partner. "It's sort of exciting for me that I'm writing for a different audience, and that I get to explain to all these [scientists] what we do as librarians, the tools that we use and the value that we bring.." (P4)

2.7 Professional Identity

One of our original research questions was, "How can SLA foster the development of non-traditional roles for IPs in collaborative biomedical research?" To that end, we asked participants several questions about their professional identities, including how they came to work in the field of biomedical research, what professional organizations they belonged to and whether or not they felt supported by those organizations, and how they stayed current in their field.

Like the professionals featured in Osterbur et al., participants in this study came to their positions via unique paths. (Osterbur et al.) A selection of vignettes from this study similarly illustrates these diverse paths.

- Participant 5 had a BS in zoology, worked in a lab, then returned to school for a master's in library and information science particularly with a health science focus. Participant 5 wanted to work as a liaison and was very interested in health information, but knew that she did not want to be in a clinical setting.

- Participant 7's PhD in a scientific field was leading to a lifetime of getting grants to establish a lab. She had been the "library person" on her lab team and applied, on a whim, for a position which would utilize her science background and her information skills in the health sciences library where she is now employed.

- As a student in health sciences, Participant 9 became acquainted with librarians who served as role models. Her scientific background led to a first professional librarian position as a biosciences librarian.

- Participant 10 was set on not becoming a librarian or doing anything that had to do with computers, as her family had generations of these. Participant 10's dream of a career in humanities was not fulfilled, but library science offered a sustainable occupation. When her instructor challenged Participant 10 to write a specific paper for an award, Participant 10 was hooked on librarianship and the variety of areas of expertise that fell broadly under its umbrella.

- Participant 11 sought a career change and discovered that the ability to work – and lead – in a chaotic or changing environment was a useful and transferable skill for academic research library services.

Both participants who held science PhDs commented on the pros and cons of revealing their degrees to researchers. "In my email, I don't have 'PhD' on there because I want people to just treat me like a librarian, and ask me the kind of questions they would [of any librarian]. When I'm working with faculty though, sometimes I have to I let them know. It does help. Sometimes people don't realize that you understand exactly what they're talking about, and it's good to know upfront that they can be frank and talk about their work in an unreserved way."

(P14) When asked if she felt her PhD gave her an advantage in her work as a bioinformaticist, Participant 7 answered, "Yes, I do, absolutely. It opens doors that other people have a very hard time opening. I don't think it's fair, I don't like it, but I use it and I will say that my way of kind of paying it back… I feel very comfortable with doing a literature search now, but I never do them. I always say, 'I really think you should talk to a professional librarian about that. They've been trained in this…'" (P7)

2.7.1 Professional Organizations

Participants held membership in a variety of professional organizations, as many as they could afford. Over and over, participants lamented the fact that they feel as though they are stuck in the cracks between organizations. While they appreciate all that the organizations do and understand the difficulties of trying to serve such a large and varied profession, many participants expressed frustration at not being able to belong to one organization that met all of their needs. Most have very limited funds to use for membership dues and conference fees, forcing them to make difficult choices as to which organizations to join and which conferences to attend.

Table 2
Participant Membership in Professional Organizations

Organization	Participant Membership Status		
	Current	Lapsed	Interested
Medical Library Association (MLA)	9	1	1
Special Libraries Association (SLA)	5	1	1
American Library Association (ALA)		2	
American Medical Informatics Association (AMIA)	1		1
Regional library association	5		
Professional scientific or health organization	3		
Other professional organization	3		

Participants mentioned that MBG SIG (Molecular Biology and Genomics Special Interest Group) of MLA was the most often consulted peer group. However, members and nonmembers who followed the SIG still reported feeling isolated. Still, many affirmed that a direct connection with a subset of the MBG SIG group was *the* preferred source for information. The mailing listserv for MBG SIG is interdisciplinary, science-focused, library-grounded and specific, according to participants.

Nine of the fourteen participants are members of MLA, while only five are members of SLA. This was despite the fact that there was some level of dissatisfaction with both. “I would say that MLA could offer more programming targeted to those of us who are providing these sorts of roles in libraries ... there’s not enough programming to make a great meeting to go to if you’re one of us, but everybody’s library director sees this as the meeting that you go to, so that’s why everybody ends up there" (P7).

When asked about SLA, one said that the Biomedical & Life Sciences Division (D-BIO) was her peer group of choice. However, according to Participant 14, “Although it’s close, there are a lot of other people in SLA. I think there needs to be an organization for librarians serving scientists across all disciplines. It’s a challenging time for us because I think of all librarians, the science librarians are really the ones getting a hit hard because the changes in scientific communication seem to make us more relevant..."

On the other hand, Participant 4 thinks that SLA “might be a really valuable organization for me because my understanding is that it’s more varied and [has] more weird embedded librarians like me instead of MLA, [which] is almost exclusively academic sciences health librarians and hospital librarians. ... But then sometimes I feel like I’ll go to those meetings and

think, ‘I’m neither an academic sciences librarian nor a hospital librarian...’ So I wonder if [in SLA, there are] more librarians in roles like me and support for [my work]." (P4) However, Participant 4 has not actually become a member and does not have immediate plans to do so.

Participant 3, considering SLA, MLA, and ALA “[favored SLA] because of the way it supports librarians as professionals. [MLA] just doesn’t have that focus on librarians. And ALA is about libraries, not librarians, so I’ve never really felt compelled to be an ALA member." (P3)

2.7.2 Networking

Most participants indicated that their professional networks were of paramount importance. "I think people hear networking and they think it’s for professional advancement, but it’s so much more—just to hear about what other people are doing, to hear about how people are thinking about resources, and hear about how people are delivering information" (P8). Participants relied on peer networks to keep abreast of developments in their field, find relevant training and relevant conference programming.

Participants frequently discussed specific individuals at other institutions whom they could call with questions. Despite our participants being located at different institutions across the country, the same individuals were mentioned repeatedly, highlighting that this is a small and tight-knit community. Participant 7 explains that this community made her library-oriented career a better fit for her than a previous lab scientist career. “This job is what I was looking for ... there’s a great community. I have tons of friends who are librarians—I think that the profession tends to attract a certain kind of person... This is a great place to work, everybody is really well read... open to new ideas and into this ‘information wants to be free’ sort of thing, which is very different from the lab environment.” (P7)

Others found it difficult to find a community of professionals with similar roles. “This is what I think is weird about my job—I don’t think that I have any real peers and I think that this job that I have is the only job like it in the entire country, in that I work at a national level doing [my job]." (P4) Still, she has a local collaborator, participates in distance learning and travels to local meetings for face-to-face time.

Participants extended their networking opportunities by publishing in library and information science journals and in other venues relevant to colleagues. Participant 1 contributed to many blogs on e-science and used her writings to network with other librarians and subject experts. “I’m much more active on the Internet but I also try and do the orthodox system of publishing articles in the mainstream.” (P1) She was aware of the potential reach of her writing and made efforts to engage in online discussions. For a group of people who often feel isolated in their jobs, this kind of networking is a low-cost way to exchange ideas with colleagues and build community.

2.7.3 Staying Current

Participants understood the importance of staying current with new developments in not only the science of their clients but also in their own field of information science. This poses a real challenge for our busy participants. Most reported having limited continuing education (CE) budgets and limited time, yet they still found ways to get what they needed. For our purposes, “continuing education” was loosely defined as any education that provided some professional or personal guidance that was relevant to them in their position now, or that helped them arrive at their current position.

The cost of courses and conferences was a major deterrent for most participants. Given limited budgets for training, most sought free or low-cost CE options. "[I take] anything streaming or posted that I can skim off." (P10) Webcasts, for Participant 2, were a way to get frequent and relevant training at a low cost. One participant noted that, in her case, funds for CEs were plentiful but were limited for conference fees and professional dues.

Participants also identified CE opportunities as an important factor when considering their professional affiliations. One reported that he liked to "keep up with the MOL-BIO [MBG SIG email list] and Public services sections (especially expert searching) listservs" of MLA, but did not seek CE in that area offered by MLA. (P14)

Table 3
Continuing Education (CE) and Participant Completion or Interest

CE or Opportunity	Participant Status	
	Completed	Desired
Clinical skills for medical librarianship	1	
Computer programming languages		2
Coursework toward degree/certificate in field	2*	
Curriculum development	1	
Digital libraries		1
Dreamweaver, web publishing	3	
Electronic health records		1
Evidence-based medicine	1	
General science education for nonscientists; translational science introduction		2
Health information resources, policy	2	1
Library management		1
Medical terminology	1	
Mobile technologies for libraries	2	
NCBI courses/NCBI databases	1	1
Other courses at conferences, general updates	4	
Reading and assessing scientific literature	1	
Scholarly communications		1
Systematic reviews; expert searching	3	1
Web 2.0 and social media	5	1
Bioinformatics course at Woods Hole, MA	2	

*Coursework in process

Participant 3 said that self-education within the subject area goes a long way. In her opinion, reasonably bright people can learn things on their own and the lack of a science background is not a career hindrance. She notes that she has acquired important subject expertise because she has been embedded in her environment for so many years.

Conversely, Participant 13 found that “as the years go on, I become a little less well versed in the research language, and so I have to go back and... literally study what’s going on. And ...whenever we have a new investigator [come in], I usually end up talking to them and finding out a lot about their research." Participant 9 said, “You have to be willing to learn about it because otherwise, you can’t talk the talk. It’s very difficult to embed yourself if you don’t understand what specific receptors are or ontology—it can be a lot of work." Participant 11 credited being at the right place at the right time for learning on the job by “going to these lab meetings, and reading up on the science and reading their publications” but also wanted to study science formally. “I can definitely see where I will get to a point where my lack of science background will hold me back, in ... terms of the help that I could be providing." (P11)

2.8 Summary

Participants, then, were engaged in innovative service delivery and blazing new trails in the support of biomedical research. Though they identified strongly with their environments and were excited about the future of librarianship, they reported feeling isolated and in need of greater professional support. In the following sections, we recommend several ways professional organizations and research institutions can better support this community. We also discuss ways to integrate librarians more deeply into biomedical research.

3. Recommendations

Based on what we have learned from conversations with our participants, we make recommendations in two areas:

1. Integrating librarians into biomedical research
2. Opportunities for professional organizations, especially SLA, to better serve this community

3.1 Integrating librarians into biomedical research

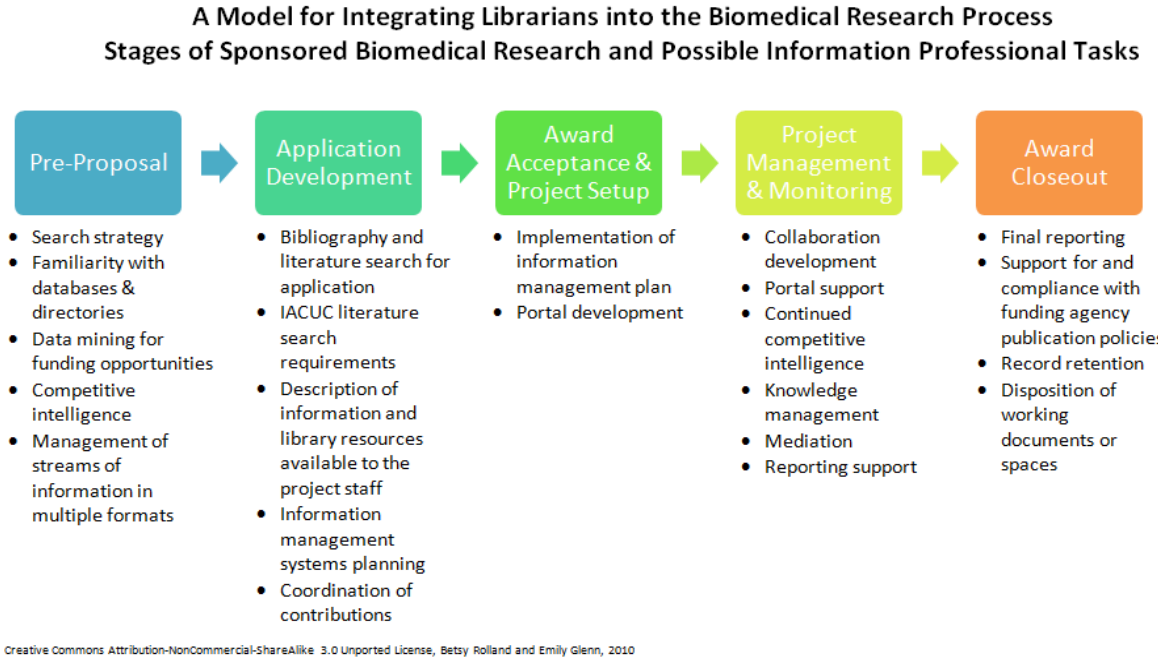
The most important take-away message from this study is that librarian involvement is possible and desirable in all phases of biomedical research. Traditional library services took place in the library primarily when the research staff needed a specific answer. Our participants have proven that there is value and advantage to researchers in utilizing information services and the skills of librarians at all stages of the research process. They have also proven that, given the opportunity, librarians will identify needs researchers did not even know they had and propose solutions no one has thought of before.

Integrating a librarian as a core team member has substantial benefits. In our Research Agenda, below, we propose that more research is necessary to determine the optimal mix of services that will best support biomedical research and how to quantify those benefits. In the meantime, the discussion of services in this report is a good place for libraries to start when thinking what new services they might want to offer and how to better integrate librarians into their research programs. Performing a thorough user-needs assessment of current researchers

and connecting with other, peer libraries to discuss what services they offer are ways to start thinking about the next generation of services needed by today's scientists.

A model for integrating information professionals into the research lifecycle was presented by the authors in 2009 in a presentation delivered to the Society for Research Administrators Annual Conference. (Rolland and Glenn) The audience for this presentation was research administrators and has a more detailed list of possible general areas for services.

Figure 1.
A model for integrating librarians into the biomedical research process



As we learned from participants in our study, outreach is a crucial aspect of the successful offering of new services. Marketing both the service and the librarians themselves is an essential part of the process and cannot be skimped on or skipped over. As discussed in Section 2.4, Outreach, our participants utilize 5 key techniques: (1) Developing a web presence, especially using Web 2.0 tools like blogs, wikis and social networking sites; (2) Attending faculty,

departmental and lab meetings; (3) Word-of-mouth and taking advantage of existing connections; (4) Hallway conversations; and (5) Reference desk referrals.

One of the most successful ways of integrating librarians into biomedical research seems to be finding ways to have them written into sponsored research, as described in Section 2.5, Funding. This approach takes time and may involve several failed grant proposals, but the end result is advantageous for the library and the librarians themselves. We recommend that librarians and library administrators investigate this option.

3.2 Opportunities for professional organizations, such as SLA, to better serve this community

This is a field that is growing quickly and changing rapidly and is comprised of professionals who feel they do not have a professional home. Organizations such as SLA are poised to offer that home if they take the time to investigate and understand the needs of this group.

As discussed in Section 2.7, Professional Identity, we asked participants what professional organizations could do to better support them in their work and in their careers. Most felt the organizations were doing an adequate job but could be doing much more. Their recommendations covered career development, networking opportunities and degree programs.

Participants were very motivated to continue developing their careers, which requires staying on top of changes in both the science of their clients and their own field of information science. Professional organizations can help dramatically with this by offering CE courses. As mentioned above, however, money is a substantial barrier to participating in CE courses.

Solving this problem demands fresh, innovative solutions on the part of professional organizations. Streaming synchronous and asynchronous online classes can help ease the financial burden, as they do not require a travel budget. Encouraging SLA members to produce training courses for each other is another potential money saver. Perhaps a push toward smaller, regional meetings could also serve the needs of those who want further training but have small budgets.

Because this group feels so isolated, they are hungry for more networking opportunities and long to be connected with others in similar positions. They want to be sure that, if they attend a conference, there will be sufficient relevant programming and a critical mass of librarians like them. Just as science is increasingly specialized, perhaps librarians, too, are becoming specialized. Perhaps the term "science librarian" is too broad and conference programming designed to meet the needs of a science librarian is too broad, serving no one fully. As librarians expand their service offerings outside of the traditional realm, they are developing solutions that may be specific to their domain and therefore no longer apply to scientists in other fields. We recommend that SLA investigate this question: Can SLA better support librarians in biomedical research?

Nine of our fourteen participants are members of MLA, while only five are members of SLA. MLA's programming at this year's conference demonstrates that it is expanding more into support for science librarians; SLA runs the risk of losing this group. Most participants can only attend one conference due to funding restrictions; they choose the one with the best programming and networking opportunities. If their peers are all going to MLA, they are going to MLA, too.

Many of our participants expressed surprise that SLA funds professional research such as ours, while lamenting the difficulty of securing their own research funds without a PhD. This could be a significant opportunity for SLA to expand its sphere of influence through greater funding and visibility of such research projects. Participants recognized the need for publishing in peer-reviewed journals such as the *Journal of the Medical Library Association*. SLA does not currently have such a publication and could possibly benefit from expanding into this area, giving its members an opportunity to participate in the world of scholarly publishing as authors. By doing so, librarians gain credibility with their clients, who exist in the world of "publish or perish."

SLA could also get involved in preparing future science librarians by seeking to influence courses that are offered in LIS programs. Courses on the scientific research environment, grant writing, bioinformatics and science resources could open up doors for students.

4. Research Agenda

Our study generated many unanswered questions surrounding the role of librarians in biomedical research. We propose three related areas for further study:

1. What more are librarians and libraries doing in the biomedical research field?
2. What is the real, measurable effect of offering these new services?
3. How can librarians be better supported in trying to develop and offer innovative services?

4.1 What more are librarians and libraries doing in the biomedical research field?

While our study is a good beginning, it is not a comprehensive, representative sample but rather a self-selected group of participants who volunteered to be a part of our study. It would be extraordinarily useful to do a more comprehensive survey of biomedical research institutes and medical schools to find out what services their libraries are offering, to whom, and what they charge. It would also be interesting to hear how these libraries are staffed. These data could then be used by libraries to evaluate their own service offerings. This work would be best done in conjunction with an updated investigation of what biomedical researchers really need in order to find out if there are needs that are specific to this domain or if the needs of biomedical researchers are similar to those of other scientists. This research could also be used to develop a standard evaluation program for biomedical research libraries.

It is also probably true that investigators are having some of their information needs met outside of the library, by departmental support staff or biostatisticians. It could be useful for libraries to identify those services and those individuals providing the services. Are these

services that libraries could begin to offer or could those individuals be brought into the library? How can they be coordinated? What sorts of training could libraries offer?

More research into the effectiveness of the outreach techniques described by our participants would also be useful. How can librarians best reach out to scientists and market their services?

4.2 What is the real, measurable effect of offering these new services?

Another avenue of research is the "so what" question. What is the result of adding these services to the library, for both the scientists and the library itself? Are the investigators more successful at obtaining grants and publishing research? Is there a way to quantify the effects of substantive research support being offered by librarians? Is there a optimal mix of services that is helpful for support? Are grants with librarians as part of the research team more successful? Without such hard evidence of real, tangible benefits, it is difficult to convince scientists to spend hard-won grant dollars on library services or to persuade senior institutional management to increase a library's budget to support embedded librarians.

4.3 How can librarians be better supported in trying to develop and offer innovative services?

As discussed in Section 2.5, Funding, participants are interested in pursuing original research that could benefit their clients. Unfortunately, most do not have either doctoral degrees or previous formal research experience. This raises questions about what funding agencies will accept grants from librarians and how their research can be taken seriously without PhDs. SLA, MLA, and other information-related professional organizations currently provide research grants scholarships to non-PhD librarians, but these grants are few. Librarians

have limited opportunities to conduct sponsored research in areas related to information management for biomedical research. Can other professional organizations step in to fill this research funding gap or does it need to be filled by a large funding agency such as the NLM?

Library schools may have a role to play in preparing students to become like our participants – entrepreneurial, fearless, courageous. Is it possible for degree programs to help instill those characteristics? When asked this specific question, our participants said yes. What classes can be added to get students ready for careers in biomedical librarianship? Can a certification be created to demonstrate achievement of the basic skills in this area?

As documented in the knowledge management literature, innovation often comes from translating ideas in one domain to another. Is it possible that the innovative nature of the work done by our participants can be translated to other library disciplines, such as other sciences, business or law? If so, how do we ensure cross-pollination of skills and techniques between and among different types of librarians?

It is inevitable that large data sets will be required to be deposited and maintained, either by NIH, funders, or the universities themselves. It is also inevitable that librarians will be charged with the management of these massive data repositories. How can we start training people now and influencing the conversation?

While these questions are important and crucial to the continued progress of biomedical research, it is unclear to us how any of them can be answered. To the best of our knowledge, there are few funding agencies currently funding research on such questions. The research that exists is scattered across the literature and not easily accessible. We look forward to contributing our research to this ongoing conversation.

5. Conclusion

Librarians are blazing new trails in the field of information science through the provision of innovative services to the biomedical researchers they support. Using their traditional library-based skills, including standard reference interview techniques, our participants worked diligently to craft new solutions to the problems of contemporary science. Participants emphasized that the "core" skills of librarianship are relevant to them as a librarian, but that skills must be infused with innovative approaches specific to the biomedical research environment. Scientists, in turn, are increasingly recognizing librarians as partners in their research by including them in grants and contracts and as authors on publications. It is hard to overstate the tremendous potential for librarians inherent in this development.

We would like to see professional organizations offer greater support for librarians such as our participants, who often feel isolated and lacking in a professional home. We believe strongly that library schools need to continue to develop programs to prepare more librarians for careers in science.

Finally, we have proposed a research agenda which includes further study of three main areas, including learning more about how biomedical research librarians are providing services, the effect of these services and how both professional organizations and library schools can better support this group of professionals.

National initiatives with strong support for science, such as the *American Recovery and Reinvestment Act of 2009*, have demonstrated the current administration's intention to focus on science as a way to the future. Librarians need to be ready to do their part.

Appendices

Appendix A

Initial Screening Questionnaire (delivered via SurveyMonkey)

Experimenting Outside the Information Center

Question 1:

Do you work in a biomedical research setting? (For this question, a biomedical research setting is a place where biomedical research is being conducted; or, an organization that is responsible for conducting, supporting or managing biomedical research.)		
Answer Options	**Response Percent**	**Response Count**
Yes, I work in a biomedical research setting	70.2%	40
No, I work somewhere else	29.8%	17
answered question		**57**
skipped question		**1**

Question 2:

Do you work in a library?		
Answer Options	**Response Percent**	**Response Count**
Yes, I work in an academic library	57.6%	19
Yes, I work in a special or corporate library	42.4%	14
No, I work somewhere else. Please describe the setting:		24
answered question		**33**
skipped question		**25**

Question 3:

Do you contribute to the work of biomedical researchers by providing services in any of the following areas? Check all that apply.		
Answer Options	**Response Percent**	**Response Count**
Instruction for local investigators using information resources developed by collaborators outside of your biomedical research setting	42.5%	17
Instruction for collaborators on using information resources developed by investigators in your biomedical research setting	27.5%	11
Project management	35.0%	14

Web-based portal management (including structure, metadata, workflow or information management for online collaboration spaces)	37.5%	15
Data coordination and presentation, including repository contributions and management of research output	25.0%	10
Remote support of external collaborators in any of the above activities	22.5%	9
Computer programming	12.5%	5
Knowledge management system to track personal contacts of investigators	7.5%	3
Knowledge management system to track research progress of investigators	7.5%	3
Scholarly communication or authorship support	47.5%	19
Dissemination of information to collaborators	42.5%	17
Support use of communication tools like web-based conferencing software	20.0%	8
Plan conferences or coordinate meetings for in-person interaction	35.0%	14
Search for relevant literature or information	72.5%	29
Taxonomy or ontology development	17.5%	7
User needs assessment	45.0%	18
Usability testing or engineering	27.5%	11
Other (please specify)		12
	answered question	**40**
	skipped question	**18**

Question 4:

Do you have a masters or doctoral degree in information science or any other field?				
Answer Options	**Information science or library science**	**Other science**	**Other non-science field**	**Response Count**
Masters degree	32	3	2	34
Doctoral degree	0	3	0	3
		answered question		**35**
		skipped question		**23**

Question 5:

Please enter your contact information.		
Answer Options	**Response Percent**	**Response Count**
Name:	100.0%	39
Email Address:	100.0%	39
	answered question	**39**

skipped question	**19**

Question 6:

What is the location of your workplace?		
Answer Options	**Response Percent**	**Response Count**
City:	100.0%	39
State:	97.4%	38
answered question		**39**
skipped question		**19**

Appendix B

Interview Questions

1. Tell us about your background, both educational and professional.
2. How do you describe your job? What exactly do you do on a daily, weekly or monthly basis?
3. Describe your workplace for us. What does your organization do?
4. Before you came here, was there an information professional on staff? If not, how (or where) was your company meeting its information needs?
5. Where does your project fit in with your organization's mission? Where does your job fit in?
6. Are you one of many information professionals or are you a "solo" information professional?
7. In your workplace's organizational structure, where do you fit in? Who are your coworkers?
8. How do you interface with others in the collaboration?
    a. Describe your relationship with your Information Technology department.
    b. Describe your relationship with your Communications or Public Relations group.
9. How do others in your project view your IP background and skills?
10. How are the skills you've learned in library school or on various library-related jobs being used in this position?
11. Which of your tasks do you feel are impacted by the "librarian" (or "i-School person") inside you?
12. How do you feel your IP background and skills are affecting the research?
13. Do you think your project runs differently than others because of your IP background and skills?
14. Do you have any "success stories" to share about our contributions here?
15. What kind of outreach have you conducted at your workplace?
16. When you think of advocacy and visibility, how would you compare your position with that of your peers in similar positions?
17. What other kinds of IP skills would you like to develop?
18. In the past year, what kinds of continuing education courses have you taken?
19. Do you identify as a/an: informationist, librarian, bioinformation specialist, information specialist, bioinformatician or other?
20. How do you meet or stay connected with others who have similar professional interests?

Appendix C

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Appendix D
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