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Interdisciplinary research training in a school of nursing

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Abstract

Although interdisciplinarity has become a favored model of scholarly inquiry, the assumption that interdisciplinary work is intuitive and can be performed without training is short-sighted. This article describes the implementation of an interdisciplinary research training program within a school of nursing. We describe the key elements of the program and the challenges we encountered. From 2007-2010, eleven trainees from 6 disciplines have been accepted into the program and 7 have completed the program; the trainees have published 12 manuscripts and presented at 10 regional or national meetings. The major challenge has been to sustain and “push the envelope” toward interdisciplinary thinking among the trainees and their mentors, and to assure that they do not revert to their “safer” disciplinary silos. This training program, funded by National Institute of Nursing Research (NINR), has become well-established within the school of nursing and across the entire University campus, and is recognized as a high quality research training program across disciplines, as exemplified by excellent applicants from a number of disciplines.

As part of the National Institutes of Health Roadmap Initiative (which has now evolved into The NIH Common Fund, <http://nihroadmap.nih.gov/>), The Center for Interdisciplinary Research to Reduce Antimicrobial Resistance (CIRAR) was funded in 2004 by the National Center for Research Resources (Grant # P20 RR020616) and is now an established, ongoing Center supported by the Columbia University School of Nursing (<http://www.nursing.columbia.edu/CIRAR/>). The Center was initially co-directed by a nurse researcher and an infectious disease physician and included faculty from 16 different disciplines and/or departments. Although interdisciplinarity has become the model of scholarly inquiry frequently espoused by researchers, the assumption that anyone can do interdisciplinary work with no preparation is incorrect. It became clear early in the development of CIRAR that some researchers/potential mentors were eager to collaborate across disciplines and others found it tedious and time-consuming; it was not everyone's cup of tea. We also noted that certain skills increased the likelihood of success of the interdisciplinary efforts and hypothesized that these skills could be learned.

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Based on our experience with CIRAR, we developed a training program to enhance the interdisciplinary research skills of pre- and post-doctoral health sciences students. The Training in Interdisciplinary Research to Reduce Antimicrobial Resistance (TIRAR) program was funded in 2007 by The National Institute of Nursing Research (NINR, T90 NR010824). To our knowledge, this is one of the first training program funded by NINR to develop interdisciplinary researchers in a variety of health care disciplines. The aims of this article are to describe the development and implementation of an interdisciplinary pre- and post-doctoral research training program within a school of nursing, to describe its key elements, and discuss challenges and future directions.

Rationale for Interdisciplinary Research

Dr. Alan Leshner, Chief Executive Officer of American Association for the Advancement of Science and publisher of *Science*, has noted that no discipline can stand alone any longer and suggests that “the organization, structure, and funding strategies of both academic institutions and governmental science-supporting agencies should be reexamined.”¹ Going even further, The Institute of Medicine Report “Who Will Keep the Public Healthy?” identifies transdisciplinary research, which crosses several disciplinary boundaries to create new approaches, as essential to public health in the 21st century, but also notes that the understanding necessary to bring this paradigm about is limited.² In one national study, 815 informants in 63 partnerships reported that the most important predictors of the success of the partnerships were the effectiveness of the leaders and efficiency (i.e., productivity) of the partnership.^{3,4}

Disparate values, knowledge bases, and approaches to inquiry can hinder research collaboration.⁵ In one case study of a cross-disciplinary collaboration, for example, there was no improvement in outcomes because individual disciplines had differing views of the collaborative environment and there was no agreement on the management and characteristics of successful interdisciplinary research.⁶

There is evidence, however, that collaboration can be improved. Across 111 interdisciplinary geriatric teams in US Veterans Affairs medical centers, the more education the team members had regarding the interdisciplinary process, the more prominent and task-oriented they were. Among 193 scientists and technologists from 20 research teams, team climate (e.g., trust, open communication) and innovation were important indicators of research productivity.⁷ McCarthy⁸ notes that the biological sciences particularly benefit from an interdisciplinary approach because of the shift from individual descriptive studies to a global, systems-oriented investigative mode.

An impressive evaluation of a scientific transdisciplinary collaboration was conducted from 1999-2004 by the NIH-sponsored Transdisciplinary Tobacco Use Research Centers program.^{9,10} Using a battery of qualitative and quantitative methods, they examined antecedents, processes, and outcomes of the program, which are summarized in Table 1. Key contextual circumstances that enhanced members’ readiness to participate in transdisciplinary work included a narrow versus broad disciplinary makeup of the group, spatial proximity, streamlined administrative arrangements, and previous experience working together. Others have also identified the importance of spatial proximity and the need for supportive environmental conditions to facilitate collaborative work such as the building of trust across disciplines and the garnering of commitment and leadership.¹¹⁻¹⁴

Thus, the goal of interdisciplinary research is to apply various approaches and methodologies to solving intractable problems that have not been amenable to resolution by any single discipline,^{15,16} and research suggests that an interdisciplinary culture must be well-planned and executed to maximize the potential for success. Much is known about how

to develop successful, sustained research teams, but there are still gaps in knowledge and there is need to systematically assess the outcomes and costs of collaborative research. It has been suggested that the single most important contribution to interdisciplinarity would be to accurately characterize the methods of interdisciplinary research.¹²

Key Elements of the Interdisciplinary Research Training Program

Using information that we learned from the published experience of others as well as what we learned from CIRAR, we have implemented TIRAR using a deliberative and iterative process, which is described below.

Establishing Conceptual Underpinnings and Training Goals

As part of the initial planning for CIRAR, we convened several interdisciplinary working groups charged to establish liaisons with appropriate internal and external groups, to assess the outcomes and predictors of success of interdisciplinary research, define core competencies essential to successful interdisciplinary research collaboration, and identify gaps and an interdisciplinary research agenda to fill these gaps. An important early activity was to identify the strengths and expertise of our team members and what we could contribute to a well-balanced training program. The interdisciplinary working group members were selected based on their varied expertise in order to bring “fresh eyes” to the topic, as well as their interest in interdisciplinary research and track record as mentors. Through a series of team meetings over a period of about 6 months, we identified 8 specific areas of expertise and 6 populations with which we had experience and in which we could offer mentoring. These areas of expertise and experience among the members of CIRAR helped to direct our discussions with potential training applicants so that they would be informed of areas in which we could offer specific mentoring, and assisted us in matching fellows with mentors.

Consistent with the concepts of translational team science,^{17,18} we also identified 3 overlapping translational levels of focus for our collaborative research: improvements in outcomes among individuals, health systems, and health policy. Some of the CIRAR collaborators were focused primarily on clinical research in which the individual patient is research participant (i.e., outcomes among individuals). Other members of the team were health policy and systems researchers. This model was used to depict the concentric interface between these 3 levels of research and to illustrate the need to create multi-faceted approaches rather than remaining segregated in terms of research approaches as well as disciplines. Our resultant conceptual model is depicted in Figure 1.

In order to determine what elements should be included in the training program we conducted a critical literature review to develop an operational definition of interdisciplinary research. After the extensive literature search, the following definition was adopted:

Interdisciplinary research is any study or group of studies undertaken by scholars from two or more distinct scientific disciplines. The research is based upon a conceptual model that links or integrates theoretical frameworks from those disciplines, uses study design and methodology that is not limited to any one field, and requires the use of perspectives and skills of the involved disciplines throughout multiple phases of the research process.¹⁵

We also conducted a needs assessment using an electronic survey at the study institution to determine whether such a training program would fill a gap; 143 potential trainees or applicants to various schools, including nursing (23.8%), infectious disease (18.2%), dentistry (17.5%), microbiology/laboratory science (16.1%), medicine (11.9%), and a range

of other academic fields completed the survey. Of these, 82% expressed an interest in an interdisciplinary training program in antimicrobial research.

Finally, using a Delphi survey of national experts in interdisciplinary research, a set of core competencies necessary for interdisciplinary research was identified by group consensus.¹⁶ While scholars exposed to thinking of multiple disciplines have moved to integration of perspectives and many have mastered these competencies, such learning may not occur until many years into a research career. With the competencies specified, it was then possible to articulate a curriculum that prepares a new researcher for interdisciplinary studies from the outset of his/her career. This preliminary planning took approximately 2 years.

Planning Programmatic Components

Based on this preliminary work, the training program developed includes 3 key activities: (1) a didactic 2-credit graduate course, “Building Interdisciplinary Research Models”, (2) a monthly Interdisciplinary Research Seminar, and (3) Supervised Field Experience. Trainees are required to have a team of at least 2 mentors—one is the “CIRAR mentor”—whose responsibilities are primarily to provide the trainee with career development advice and guidance. The second mentor must be in a different discipline from the trainee to provide content expertise, help to identify a supervised field experience, and to “push the envelope”—directing the trainee to examine his/her research interests from a completely different perspective. Pre-doctoral students are expected to select their dissertation topic in the content area of the Center and all trainees are expected to produce at least one publishable paper with a co-author outside their discipline. All pre- and post-doctoral fellows must present their works-in-progress at a monthly interdisciplinary CIRAR seminar as well as at a monthly collaborative seminar conducted jointly with pre- and post-doctoral fellows in the Center for Infectious Diseases Epidemiologic Research (CIDER), funded by The National Institute of Allergy and Infectious Diseases, thus providing another opportunity for expanding their interdisciplinary networks.

A CIRAR/TIRAR Steering Committee comprised of 7 members (nursing, social work, pathology and cell biology, medicine [infectious diseases and pediatrics] and public health) meets at least annually to discuss and contribute to the progress of each grant within the Center; facilitate communication among and between research teams; resolve issues, challenges, and difficulties; assess and enhance the interface among grants to potentiate their value; identify gaps in knowledge in the field; develop additional interdisciplinary grants; plan educational and communication strategies for dissemination and sharing of knowledge; and evaluate the interdisciplinarity and functioning of the program.

Selecting and Recruiting Fellows

The training program is open to pre- or post-doctoral applicants in any field of study who meet the qualifications. Requirements for pre-doctoral trainees include successful completion of all first-year course requirements of graduate study in any research doctoral program within the University and a strong interest in interdisciplinary research that can be related to antimicrobial resistance in some way. The respective doctoral program awards the degree for each student; our training program requirements are compatible with the degree requirements of all participating programs. Each pre-doctoral trainee is expected to complete a dissertation in the general field of antimicrobial resistance. For post-doctoral trainees, fellowship requirements include a doctorate from an accredited institution, a strong record of accomplishment as evidenced by peer-reviewed publications, an articulate goal statement that confirms their interest in both interdisciplinary research and research related to antimicrobial resistance, and letters of support from 3 referees.

Since this was our first experience at recruiting trainees across a wide range of disciplines, departments, and schools, a particular challenge was determining how best to disseminate information about the program. The usual channels of communication within a single discipline (e.g., professional organizations and disciplinary publications) did not provide a sufficiently wide swath to reach across disciplines. Therefore, we contacted each school within the University and identified University-wide listserves and web sites with which we could interface. We developed a list of other research centers across the campus and then convened a group of interdisciplinary center leaders for a day-long workshop to address barriers to interdisciplinary research; results of that workshop are summarized by Glied and colleagues.¹⁹

We have also developed strong ties with the institution's Clinical and Translational Science Award (<http://irvinginstitute.columbia.edu/news/seminars.html>), which shares many of the same goals as the training program. A website and a Center listserve serve as the primary means of communication to a larger audience. The steps and challenges encountered in developing the training program are summarized in Table 2.

The objectives and content of the didactic interdisciplinary course were designed to address the core interdisciplinary research competencies identified in the Delphi study. The course is currently co-taught by faculty members from the School of Nursing and the Department of Biostatistics in the School of Public Health. It has been offered twice; 32 doctoral and post-doctoral enrollees have included students and faculty members from social work, nutrition, medicine, public health, and nursing. Like TIRAR fellows, other students taking the formal course must complete a field experience outside their discipline and assess the functioning of the team using 6 factors—intrapersonal, interpersonal, organizational/institutional, physical/environmental, technologic, and sociopolitical—described by Stokols et al.²⁰

Assessing Outcomes

From 2007-2010, 11 trainees from 7 disciplines (nursing, medicine, computational biology, biomedical informatics, microbiology, epidemiology, genetics and development) have been accepted into the program and 7 have completed the program. The 7 who have completed the program now have research positions in several academic institutions, one is still completing the dissertation, and all have maintained a strong interdisciplinary focus in their scholarly pursuits. For example, one is assistant professor of nursing who has recently submitted an R01 with a veterinarian colleague and one is a microbiologist working with an interdisciplinary group on an NIH-funded clinical trial. To date, the fellows have published 12 manuscripts with interdisciplinary authors and presented at 10 regional or national meetings. The diverse nature of the fellows' work as well as the integration of our conceptual model, which includes researchers with expertise at the individual, systems and policy levels, is exemplified in the sample list of publications/presentations in Table 3. The work of the program has been widely disseminated. The website currently receives approximately 1500 "hits" per month from around the globe, as noted in Figure 2.

Evaluation of outcomes is often a major challenge in training programs such as TIRAR. In order to obtain data from various sources, in addition to their regular meetings with their mentor team, fellows meet at least quarterly with the training director to discuss career advancement, a formal written assessment by the fellows and their mentors of their interdisciplinary competencies and progress, takes place when they arrive and then biannually, and the steering committee discusses each fellow's progress when they meet. Trainees and their mentors are also asked to write a short qualitative assessment of their experience. Typical samples of narratives from a previous postdoctoral fellow and a member of the Steering Committee and faculty mentor are included as Exhibit 1.

Challenges and Future Directions

After the first 3 years of the training program, our major challenge continues to be encouraging our collaborating faculty and the fellows to move outside their disciplinary and methodologic “comfort zones” to address research questions from different perspectives. It has been far too easy to “backslide” into disciplinary silos, as has been noted by others as well.²¹ For example, presenters in our monthly seminars have often failed to include an interdisciplinary perspective, resulting in a loss of the unique purpose of the seminars. To address this, we have designated respondents following presentations to focus in particular on the interdisciplinary implications of each project, and have also reminded presenters prior to the seminars to include an interdisciplinary perspective.

A related challenge is maintaining the interest of a rich cadre of researchers from multiple disciplines so that they continue their active involvement in the program as mentors. Researchers will “drop out” of the Center and the training program unless there are clear benefits to them in terms of expanding or enhancing their own work. To address this challenge, we have expended considerable effort in assuring that the fellow-mentor match is synergistic. Even though their specific areas of interest may differ, we have found that the fellows can assist with secondary data analyses or data collection and, thus, benefit from expanding their experience with various approaches and methods to conduct research.

Sustaining an interdisciplinary research center over time requires both the ongoing cadre of researchers as identified above, but also a steady pipeline of pre-doctoral applicants for fellowship. The cynic would say that the costs of education are such that there would always be applicants, but the serious question is the supply of applicants who have some sense of what it means to mature into a scholar with interdisciplinary skills and perspectives. In that regard, exploring ways to expose beginning doctoral students to the potential excitement of a program such as TIRAR would be useful. It would also be useful to consider whether the current requirement for some established track record in a field (the successful completion of one year of study, as identified above) is really essential, or whether a student enrolled directly in an interdisciplinary program might more fully achieve the desired end point.

Exhibit 1 Comments From Pre-doctoral Trainee and Faculty Mentor

Fellow: During my doctoral studies in microbiology, I developed an academic interest in epidemiology. However, having completed only a few courses in this area, I found that I lacked much of the background and experience needed to bridge the two disciplines. Two years as a post-doctoral trainee in the TIRAR program enabled me to develop the interdisciplinary acumen and confidence needed to conduct collaborative, productive patient-oriented research. This traineeship provided valuable interactive learning experiences through its curriculum, which included presenting the products of our research for diverse audiences; the field experience practicum, which allowed protected time to explore a field and methods outside of my disciplinary knowledge; and by enabling me to continue epidemiology and biostatistics coursework, which both augmented my skill set and helped me to transform my research into publishable form. Most importantly, TIRAR facilitated a pairing with a mentor who was experienced in conducting applied interdisciplinary research in my areas of interest (epidemiology and clinical microbiology).

Beyond the valuable relationships I formed with my mentor and field experience preceptor, TIRAR allowed for networking and connections with faculty members who started out in distinct disciplines and later forged unique paths to interdisciplinary, collaborative research careers. I found this group of faculty to be a great resource for us as trainees, both as we developed and completed research projects, and as role models as

we develop our capacities as interdisciplinary researchers. One of my favorite aspects of the traineeship was working alongside other trainees. This experience was instrumental in expanding my ability to converse outside of my discipline, and it led to fruitful brainstorming sessions and stimulating conversations about research challenges, future opportunities, and career planning. I anticipate that my fellow trainees and I will continue to be resources for each other as our careers progress and may become future collaborators as we continue to expand our interdisciplinary capabilities.

Interdisciplinary Faculty Mentor: I have mentored dozens of physicians training in pediatrics and pediatric subspecialties. This was my first experience mentoring someone outside of my discipline who themselves had a skill set (i.e., molecular biology) that was far less familiar to me than clinical medicine and clinical research. The challenges I conquered throughout this interdisciplinary experience largely reflected the “discipline” needed to devote the time and energy both to acquire new vocabularies and concepts myself and to teach new vocabularies and concepts to the other mentors and the trainees. I have found it challenging to acquire interdisciplinary concepts and must continually restate what I think I have understood to be certain I have learned. I have also found it challenging to teach my vocabulary to others; it is critical to figure out how to strike a balance and not be overly simplistic and superficial or too abstract and specialized. I cannot overstate the feeling of satisfaction that results when the vocabulary is acquired or the concept mastered. The metaphor that comes to mind is toiling over a lacquered box that requires numerous coats of paint before acquiring the desired result.

With regard to the supply of post-doctoral fellows, it is likely that a sufficient number of individuals will have had some experience that points toward the potential intellectual and academic rewards associated with an interdisciplinary approach. Seeing the steady production of findings in respected journals will further affirm that spending some time in this environment is an asset.

As stated in the National Academy of Sciences Report, *Facilitating Interdisciplinary Research*, “Interdisciplinary research and education are inspired by the drive to solve complex questions and problems, whether generated by scientific curiosity or by society, and lead researchers in different disciplines to meet at the interfaces and frontiers of those disciplines and even to cross frontiers to form new disciplines.”²¹

While the Report identifies major disincentives and barriers to achieving the aims of interdisciplinary work, similar to those which we have encountered, it also emphasizes the inherent value added to the educational process when students interface with multiple disciplines. The basic drivers for interdisciplinary research, as pointed out in the Report, include the inherent complexity of nature and society, the need to solve societal problems, and the stimulus of generative technologies. We urge that a greater emphasis be placed on assuring that students and fellows in nursing be immersed in interdisciplinary experiences such as we are implementing in TIRAR. This training program, housed in a school of nursing and funded by NINR, has had an impact on the development of nursing scholars by demonstrating leadership in the development of new knowledge. It has also had an impact across our entire University campus and is recognized as a high quality research training program across disciplines, a model of 21st century science. Building interdisciplinary competencies in, and facilitating relationships between, new researchers is a challenging process but, ultimately, we believe it is one that will move research methods, findings, and the profession forward.

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Figure 1.
Conceptual model for interdisciplinary research training.
Source: Adapted from Peirce, Cook and Larson.²²

Figure 2.
Sample of previous 100 “hits” of CIRAR website (as of 11/8/10), 48% U.S. and 52% international (<http://www.nursing.columbia.edu/CIRAR/TIRAR.html>).

Table 1

Components of Successful Interdisciplinary/Transdisciplinary Scientific Collaboration, adapted from Fuqua et al.⁹

Antecedents	Processes	Outcomes
Disciplinary scope (shared values, expectations, experience, goals) Physical environment (proximity, interaction) Minimal bureaucratic and structural issues	Social capital Social cohesion and (in)formality of interactions Ease and rapidity of collaboration	Novel ideas Integrative models New training programs Institutional changes Innovative policies

Table 2**Steps in the Process of Developing an Interdisciplinary Research Training Program**

Step	Challenges
Enlist potential scholars and faculty mentors from a variety of disciplines	Interdisciplinary work requires additional time and effort; some faculty members are not interested
Identify areas of expertise of involved faculty members and articulate the conceptual underpinnings of the program	Learning to communicate and reach consensus across disciplines with varying perspectives, research approaches, language and values
Adopt a working/operational definition of interdisciplinary research	Definitions in the literature are highly variable; the group must reach consensus on how they will operate
Identify core competencies needed for interdisciplinary research	No competencies had been previously articulated
Conduct needs assessment to determine potential student interest/commitment/need for interdisciplinary research training	Since the program is interdisciplinary, it is difficult to identify the best ways to reach potentially 'new' groups outside the single disciplinary organizations and publications
Develop criteria for trainees and new communication venues to disseminate information about the program	See above
Identify personal, professional and institutional barriers, and facilitators for interdisciplinary work	It is vital to move beyond discussing barriers to identifying local strategies to facilitate the process

Table 3

Sample First-Authored Publications/Presentations from Interdisciplinary Research Fellows, Including Disciplines of Authors

Citation	Disciplines
Dunn-Navarra AM , Cohen B, Stone PW.* Pogorzelska M, Jordan S, Larson E.* Relationship between systems-level factors and hand hygiene adherence. <i>Journal of Nursing Care Quality</i> 2010 Epub ahead of print.	Epidemiology, Nursing, Economics, Health Systems Research
Landers T , Apte M, Hyman S, Furuya Y*, Glied S,* Larson E*. A Comparison of methods to detect urinary tract infections using electronic data. <i>The Joint Commission Journal on Quality and Patient Safety</i> , 2010;36:411-7.	Medicine (internal medicine and infectious diseases), Nursing, Epidemiology, Health Policy and Economics
Scanfeld D , Scanfeld M, Larson EL.* Dissemination of health information through social networks: Twitter and antibiotics. <i>American Journal of Infection Control</i> 2010;38:182-8.	Computational Biology, Public Policy, Nursing
Clock SA , Zhou J, Patel SJ, Alba L, Weisenberg SA, Whittier S, Schuetz AN, Della-Latta P, Jenkins SG, Furuya EY*, Kubin CJ*, Rhee KY, Saiman L*. Susceptibility of extremely drug-resistant gram-negative bacilli (XDR-GNB) to Polymyxin B and Tigecycline and management of XDR-GNB infections. In: Society for Healthcare Epidemiologists of America 19th Annual Scientific Meeting, San Diego, CA, March 2009 Abstract 72-370.	Microbiology, Medicine (infectious diseases and pediatrics), Pharmacology
Horan J , Furuya EY*, Fink SA, Kubin C. Trends in pathogens and emergence of microbial resistance in bloodstream infections (BSI) in adult orthotopic liver transplantation (OLT). <i>American Transplant Congress</i> , San Diego, CA, May 1-5, 2010.	Medicine (digestive and liver disease, infectious diseases), Pharmacology
Bright TJ , Furuya EY*, Kuperman GJ, Bakken S*. Creating an ontology for an antibiotic prescribing decision support system. <i>American Medical Informatics Association Annual Symposium Proceedings</i> 2008:888.	Biomedical Informatics, Infectious Diseases, Nursing

* Trainee listed in bold; CIRAR-affiliated faculty mentors indicated by