

Biological researchers: Building nursing science

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Nursing science addresses the individual from a multidimensional perspective, and the questions nurses generate from their practice are often grounded in basic biology. However, concern is frequently voiced as to whether there is adequate preparation and support for biological researchers within nursing. This study reports on a survey of nurse investigators funded by the National Institutes of Health who carry out biological research. All study participants were current faculty, and 48% had post-doctoral training. The majority worked with animal models. Research areas ranged from cell and molecular biology to delivery of health care. Some participants reported tension between their work and how others view “typical” nursing research. All participants had been awarded federal research funding, primarily from the National Institute of Nursing Research (NINR), and most reported receiving small grants from other funding organizations early in their careers. Self-identified factors influencing success included mentoring, flexibility, persistence, and hard work.

Nursing science views the individual as multidimensional, and recognizes the importance of psychological and social influences on personal health and health behaviors. However, the clinical problems that nurses face involving assessment of risk and vulnerability to disease, management of symptoms arising from both the disease and the treatment, and promotion of health and physiologic stability, are often rooted in biology.¹ The common areas of concern that nurses have for their patients include the basic biological processes of sleep and rest, mobility and exercise, respiration and circulation, nutrition, elimination, and immune function, along with the effects on health of gender, age, stress, symptom experience, and behavior.

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The technology of care is continually evolving, with newer and less-invasive devices available for monitoring tissue oxygenation, perfusion, and wound healing, and new drugs and therapies tailored to the cellular, and even the molecular, basis of illness.² Changes in the health care system of the United States have broadened the scope of practice for nurses, especially those in advanced practice, creating the need to enhance the theoretical, clinical, and research knowledge of biological phenomena as they relate to nursing.³

To provide optimal health care, nurses employ evidence-based practices derived from the knowledge gained through research. In 1986, nursing research gained prominence within the scientific community with the establishment of the National Center for Nursing Research (NCNR) on the campus of the National Institutes of Health (NIH). As the central federal funding source for nurse investigators, the NCNR quickly grew in stature and, in 1993, it was redesignated legislatively as an Institute, the National Institute of Nursing Research (NINR). Through ongoing scholarly assessment, community and professional outreach, conferences and work groups, and expert peer review, NINR helps to set the directions and develop the research opportunities that advance nursing science.

As a result, the science of nursing is growing at a rapid rate. The information generated from nursing research enhances the delivery of health care to patients and their families worldwide and across the lifespan.⁴ Nursing knowledge continues to expand in a broad range of patient populations and health care settings, from ambulatory and home health patients with chronic illnesses, to acute-care patients with critical, life-threatening conditions.⁵

Research exploring the biological basis of health, and the multiple pathophysiologic processes of illness, injury, and disease, has played an important part in this advancement. A recent review found articles by nurses doing biological research published in several prestigious journals both within and outside of the nursing literature, and cited by other scientists in many related disciplines. This finding demonstrates that nurse investigators in the biological sciences, in addition to advancing research, education, and clinical practice within nursing, are having an impact across the health care sciences.⁴

Studies on the mechanisms of sickness behaviors have shown that an improved understanding of the

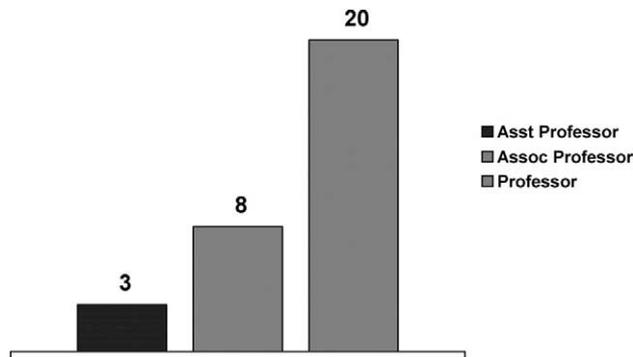


Figure 1. Academic rank.

human experience of illness can be derived from the branch of biology known as biobehavioral science. Many mid-range nursing theories, such as the human response model and the framework of psychoneuroimmunology, are incorporating physiologic and biologic concepts. Biological research by nurse investigators has explored such subjects as pain pathways, the neurological impact of diabetes, nutrition and gut motility, cerebral ischemia and stroke, gender differences in cardiac function, mechanisms of wound healing, the process of skeletal muscle wasting, pulmonary management practices, and the consequences of stress.⁶

Biology is integral to the human organism, and nursing must incorporate the contributions of biological research into practice.⁶ Unlike investigators from other disciplines, nurse investigators view the human condition from the holistic nursing perspective, seeking to understand the integrated responses of life systems within the context of the environment. “Holism cannot exist without the biological domain. . .nursing practice views the mind and body as intimately intertwined and interactive; so too should nursing inquiry.”⁵

Nursing science must continue to explore the links between health behavior and basic biology. However, the preparation and support of biological researchers within nursing has long concerned both researchers and funding agencies. Even at the beginning of the NCNR, nurse leaders determined that the amount and degree of integration of biological science was inadequate for nursing science to develop to its fullest potential.⁷ Since that time, many experts in a variety of publications have reiterated the need to further and expand the support of biological research in nursing.^{8,9,10,11}

To examine our commitment to the biological underpinnings of nursing research, we at NINR decided to look into the career paths and the contributions of our cohort of biological investigators. This article reports on a series of interviews conducted with selected NIH-funded nurse scientists involved in some level of biological research as part of their program of study. The interview questions focused on the educational preparation, research focus, and work environment of

these scientists, as well as factors they identified as contributing to their success, and advice for others seeking to pursue biological research in nursing. The purpose of this analysis was to determine some of the long-term outcomes related to these investigators, see what we can learn from their experience, and find what “return on investment” we have gained in terms of advancing the nursing profession and improving the health and health care of the nation.

METHOD

Sample

The sample for this report was 31 nurse scientists (30 females, 1 male). The convenience sample represented a group of investigators with a track record of funding from NINR or another NIH institute who employed biological techniques, measurements, or theories in their studies. All of the investigators had a faculty rank, with 27 (87%) tenured and 4 (13%) non-tenured. Figure 1 shows the academic rank of the sample. All investigators held their primary appointment in a school of nursing, except for 1 investigator who held a primary appointment in a school of medicine. (Note: the generic term “school of nursing” is used to denote both schools and colleges of nursing.) The sample included both regular faculty and faculty holding administrative positions.

Methodology

Data for this report were collected through telephone interviews using an open-ended questionnaire format. The length of the interviews ranged from 30–90 mins, with the average being roughly 40–45 mins long. When the data were being summarized, any missing or unclear responses were followed-up by e-mail queries.

The questionnaire included open-ended questions that were categorized into 6 areas: (1) current position and rank, (2) vocation/area of research, (3) education/training trajectory, (4) getting started, (5) success, (6) reflections on nursing science and career.

Data Collection and Analysis

Questionnaire responses were recorded through note-taking of direct quotes from participants. All of the

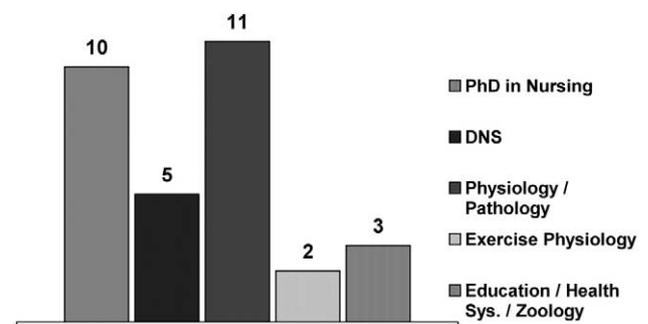


Figure 2. Doctoral degrees.

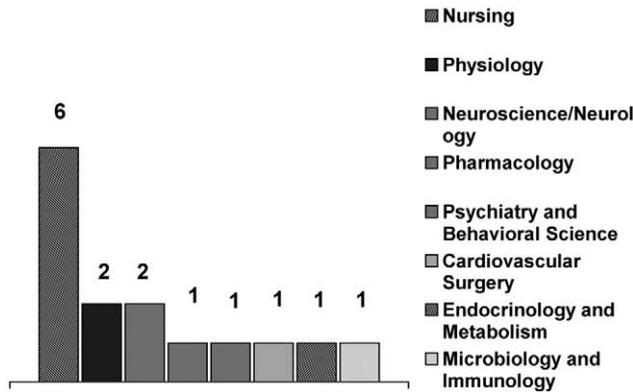


Figure 3. Discipline for post-doctoral program (n = 15).

data were collected and analyzed by the first author. The interview notes were then summarized both quantitatively and qualitatively, with responses analyzed for common themes that emerged from the interviews and for explanations that clarified or expanded answers to the questions. The majority of the responses could be analyzed quantitatively by simply counting those that emerged in each category (eg, number of participants who had a post-doctoral award, type and level of funding for pilot work, etc.). The last 2 areas on the questionnaire, success and reflections, required the most content analysis. The reported themes were those mentioned most frequently, and the quotes were selected by the authors as a means of adding richness and clarity to the data.

RESULTS

Educational Preparation and Funding

All study participants had doctoral degrees. As shown in Figure 2, the majority had received their degrees in nursing, with 10 (32%) having a PhD, and 5 (16%) having a DNS. Over three quarters (n = 24, 77%) had laboratory experience included as part of their doctoral education.

Figure 3 shows the fields of research for the 15 (48%) participants who had undergone formal post-doctoral training, with 6 (19%) doing this work in nursing, and the others in a variety of related disciplines. All who did post-doctoral work had laboratory experience as part of their education. Several participants also took additional course work and/or worked in laboratory setting with mentors without being enrolled in a formal post-doctoral program. These participants were not included in the post-doctoral count.

A very large percentage of the investigators had received some type of training grant for their doctoral program (n = 27, 87%). All of the investigators who had post-doctoral work had received funding for their education, with Institutional Traineeships (T32) being the most common mechanism of funding.

Research Topics of Investigators

Since we did not limit the interviews to those investigators currently involved in basic science research, the current research topics they reported ranged from molecular biology to exploring nursing education curricula.

As shown in Figure 4, the research questions of these participants encompassed understanding biological systems and responses to altered states of health. Many included physiological factors underlying health and illness and behavioral responses to health and illness. Study samples included cell cultures, molecular and biological specimens, animals, and humans. The biobehavioral aspect of nursing research is clearly articulated in many of their programs of research.

As investigators advance in their careers, they often change their research focus and may move back and forth between using animal models to answer more physiological questions and human subjects to answer more clinically relevant questions. Interestingly, of the 14 participants whose research involved primarily cellular or animal studies, all but 1 had completed post-doctoral work. This leaves only 2 with post-doctoral training doing research in humans.

The research paths of 3 of the participants have moved outside the biological arena. Two are currently studying factors in health care delivery, and 1 is examining the integration of specific content in nursing curricula. In each of these cases, the investigator reported that the work environment and university setting contributed to the change in research focus.

Participants identified a variety of factors that influenced them in choosing their original topic for research (See Figure 5). Almost half (n = 14, 45%) said their ideas came directly from their practice experience. Even when the topic seemed removed from direct clinical application, this identification with a practice question seemed important to many of the participants. The practice basis for the profession appears to have a strong influence in not only the research topics that investigators choose but also in the ways they describe and present their programs of research.

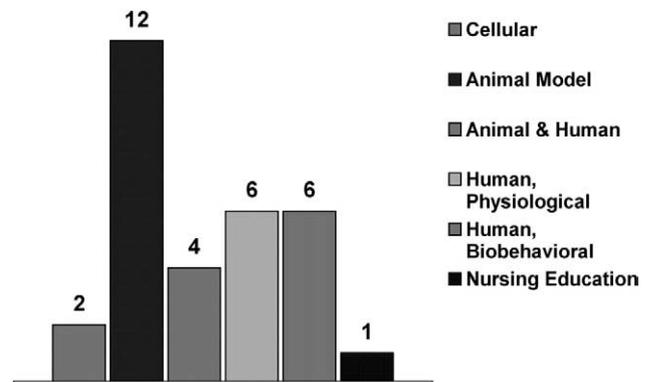


Figure 4. Overarching research questions.

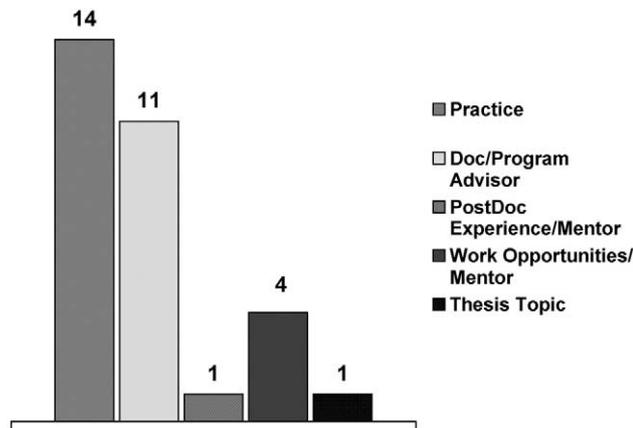


Figure 5. Source of research topic.

Work Environment

Not surprisingly, the first position following their doctoral or post-doctoral education was a faculty position in a school of nursing for the majority of participants ($n = 25$, 81%). Only 1 moved directly into an associate professor tenured position from her post-doctoral work. The other faculty appointments were non-tenure assistant professors.

Only about one-third of the sample had any type of start-up package. These packages ranged from a low of \$2,000 to a high of \$105,000, with the median at \$50,000. Start-up packages for biological investigators appear to be a recent development, with the newer graduates asking for, and getting, money to set up labs and buy equipment. Many of the more seasoned participants stated that they started out in a mentor's lab using borrowed equipment.

A very high percentage ($n = 26$, 84%) had a laboratory available to them as a faculty member. Laboratory resources varied from a fully equipped work space plus a technician, to simply a large room with a sink, with all gradations in between. The definition of "laboratory" also varied. Some had the usual basic science laboratory with sinks, refrigerators, and a variety of equipment to do assays and cultures. Others had a room holding equipment to be used in patient testing. Finally, still others defined their laboratory as a private place where they could store research equipment, or interpret printouts and results from patient tests.

Since faculty members are always concerned about workload and release time to do research, the participants were asked about sabbaticals. Only 14 (45%) reported having taken a sabbatical.

Tension Between "Biological" and "Nursing" Research

One of the common complaints among nurse scientists who do biological research is that they experience a "tension" between what they study and how others might view "nursing research." When the participants

were asked this question, the responses ranged from angry agreement to laughter. The participants with less funding experience appeared to have more unhappiness about this perception by colleagues that their research was not "nursing research." Quantitatively, 19 (61%) answered that there was tension around their program of research, while 12 (39%) said there was not. The following quotes demonstrate best how the respondents felt about this issue:

- "Nursing embraces what I do, but I still do not teach in the doctoral program. Why?"
- "I stopped dealing with that issue. I am a scientist who happens to be a nurse."
- "People have bodies, not just minds and spirits—remember this!"
- "[According to others] bench researchers are not 'real' unless they use patients."
- "I have been doing this so long; I do not feel it anymore. It is, however, a problem for my students at times."
- "People keep asking me, 'When will you move to humans?' "

These investigators reported feeling tension not only within the ranks of nursing but also from investigators in related health science disciplines who frequently are not aware that nurses can, and do, conduct biological research. Tension is, therefore, reflected by attitudes both inside and outside of nursing.

Funding Sources

Every investigator in the sample had been funded at one time by a federal agency. In fact, the number of different agencies ($n = 11$) was impressive, as was the length of time some of the investigators had received continuous funding, with 23 years of continuous funding from a federal agency being the longest reported. Two had received the President's Early Career Award for Science and Engineering (PECASE). Figure 6, A lists the federal agencies, and Figure 6, B lists the types of research awards, received by the participants. No attempt was made to quantify the amount of the awards or training grants.

Federal funding is often considered the pinnacle of peer-reviewed research. However, before they were ready to submit a federal grant application, all of the participants had been awarded smaller grants from such organizations as Sigma Theta Tau, the American Heart Association, and the American Nurses Foundation. Many participants also acknowledged getting internal support from their school or university, and they were quick to recognize the importance these small grants played at the start of their research careers. In addition, 6 of the participants had received R03 funding, a small grant award used by NINR to encourage and support more biological research by nurse scientists.

- A**
 Agency for Healthcare Research and Quality
 Department of Defense
 National Center for Complementary and Alternative Medicine
 National Cancer Institute
 National Heart, Lung, and Blood Institute
 National Institute of Arthritis and Musculoskeletal and Skin Diseases
 National Institute of Child Health and Human Development
 National Institute of Diabetes and Digestive and Kidney Diseases
 National Institute of Neurological Disorders and Stroke
 National Institute of Nursing Research
 TriService Nursing Research Program

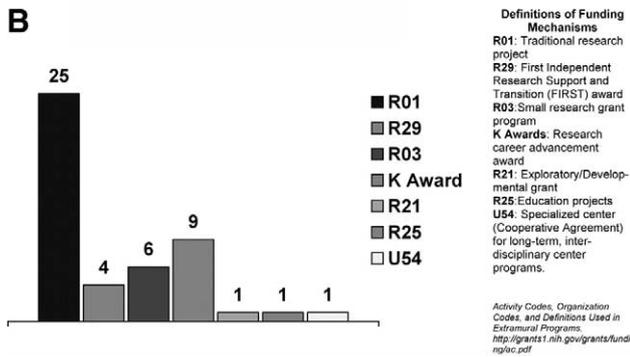


Figure 6. (A) List of federal agencies supporting biological nurse researchers. (B) Funding mechanisms received.

Factors in Success

Judging only by the funding history, the participants of this study are a group of successful researchers. When asked what contributed to their success, respondents gave multiple answers, and 3 categories emerged:

- Mentors (n = 18, 58%)
- Collaborators/Partners (n = 13, 42%)
- Funding (n = 13, 42%)

It would be impossible to list all of the mentors by name, as the participants were prolific in their responses to this query. Obviously, many of the mentors worked in disciplines other than nursing. The common pattern of mentorship was a relationship that spanned many years, and was kept alive across job changes and geographic moves by telephone calls, e-mail exchanges, and conference meetings.

The two most commonly mentioned mentors in nursing were Dr. Sue Donaldson and Dr. Barbara Hanson, two of nursing science’s early pioneers in biological research. It is also worthy to note that Dr. Hilary Sigmon, a former program director with NINR, was mentioned as being especially helpful and supportive of the work of these biological investigators. Finally, mentorship meant many things to this group. Respondents said that talking and interacting with prominent biological investigators was extremely helpful in getting feedback for their ideas and research plans. Since there have been so few nurse scientists involved in biological research, the respondents reported that any support or enthusiasm for their ideas by

a scientist already doing biological research was rewarding.

Advice for Others

Advice that these nurse scientists would offer to other nurse investigators looking to enter the field of biological research was simple: stay focused, work hard, and be persistent.

They repeatedly said a new investigator should find a mentor preferably both inside nursing and in their field of research (assuming these are not the same). They also felt that, if at all possible, an investigator should try to go to a university or research setting with an established group of colleagues and collaborators, to offer better career support and opportunities for growth. Several recognized the difficulty of this advice since nursing remains primarily a female profession, and home and family obligations often figure into work and relocation decisions. Finally, many participants encouraged new faculty to never miss an opportunity to be flexible in their work settings and responsibilities. Several reported that they had seized opportunities outside of their original plan for research, and they believed a willingness to explore and a flexible attitude helps lead to success.

Again, a few direct quotes give the flavor of the responses:

- “Look for the good mentors of the world.”
- “Nursing is looking for love in all the wrong places.”
- “If you do not have a drawer full of failures, you have not been working hard enough.”
- “It is OK to keep your head in the clouds to see what is up there, but keep your feet on the ground.”
- “You do not always need every piece of equipment that is made. Make do.”
- “You need a life outside your research.”

When asked what they would do differently in their own careers, there was a wide variety of answers, but the 2 most common were “nothing different” (n = 8, 26%) and “start earlier on my education and career” (n = 8, 26%).

DISCUSSION

This study was not intended to be all-inclusive of biological researchers in nursing. Rather, its purpose was to provide a snap-shot of a group of successful researchers who have contributed to nursing science, in order to better understand their educational preparation and career trajectories and to learn from their stories. These biological researchers are making significant contributions to science and serving the profession as nursing faculty. They honor and value the roles of mentors and collaborators. Their research is integral to interdisciplinary research teams, and they are forging new discoveries in cutting-edge research topics.

The educational preparation is interesting since nearly equal numbers had degrees inside and outside

the discipline of nursing, and all but 1 were currently faculty members in schools of nursing. While only about half of the sample had formal post-doctoral education, this career path appears to be changing. The majority of investigators in this sample were full professors, so they do not represent the newer generation of nursing and research faculty, where “post-docs” are more typical. There is an increase in funding now available through NINR for post-doctoral training, both through institutional T32 grants and individual Postdoctoral Fellowship (F32) awards. Many schools are making a bigger push to include post-doctoral preparation for faculty positions. However, the barriers of gender and family obligations will continue to play a role in these educational decisions for many individuals.

The research topics identified by these investigators did not fall neatly into categories. They ranged from cellular and molecular biology to a focus on broad system delivery questions. Many investigators expressed the opinion that once they left the basic science laboratory setting for research on humans, they had difficulty returning because of the increasingly rapid changes in research technology and methods.

The old concern of whether questions of a biological nature are truly questions for nurse scientists and whether those who engage in basic science research are doing nursing research persists, creating some tension for biological investigators. However, the responses of the investigators were encouraging. Most of them did not let this sort of controversy affect their attitudes or their work, but they were saddened by the responses of some of their colleagues to their type of research. They stated that the best defense against criticism of their work was to surround themselves with supportive colleagues, either inside or outside nursing, and just move ahead.

Success in a research career can be measured in many ways. One way is evidence of peer-reviewed funding, which all of these investigators had received, some with many years of continuous funding. As another measure, the majority of this sample was at the full professor rank in an academic setting.

While their educational preparation differed, the common theme for most of the biological researchers was the need to work with mentors who had expertise in a basic science, medical, or nursing discipline. The openness and welcoming nature of mentoring, and the collaborative relationships that these investigators described, cannot be overstated. None of them felt they could have succeeded without mentoring, and many found their mentors and colleagues primarily outside of nursing.

While there were a few exceptions, much of the mentoring and support from other nurses came in the form of helping the investigator to understand the politics of the school of nursing, traversing the academic hurdles within the discipline, and helping with

relating to both faculty and administration within the school of nursing. It appears that we are still beginning to build a cadre of biological researchers where research mentorship and support can be found within schools of nursing.

The investigators were unanimous and immutable in their belief that their research had direct relevance for the practice of nursing. Only 1 respondent stated that her early research was “medical and not nursing research.” Stating exactly how and in what way cellular and animal studies have direct relevance to practice was no problem for these investigators and, in fact, they reported being offended and upset when others questioned the applicability of their research to the clinical setting.

Many of the investigators saw themselves as serving 2 masters, nursing and the basic sciences. The requirements for “success” are different in these 2 circles. Even authorship criteria on manuscripts differ between nursing and the basic sciences in regards to promotion and tenure. These investigators have, however, figured out how to bridge these 2 worlds and are contributing to nursing science. In reviewing their advice to other investigators, there are no secret weapons for success, only focus, hard work, and persistence.

Limitations

There are 2 major limitations to this study. First, it included only nurse scientists who had been federally funded and were thus deemed “successful investigators.” Therefore, the sample included very few beginning biological researchers and no participants who have tried repeatedly to obtain funding and have failed. Second, the reporting depended on the memory of the participants and was retrospective in nature. These participants, however, appeared to have no trouble remembering their doctoral education, their work experience, or their funding sources.

CONCLUSION

This small group of nurse scientists, who have committed at least a portion of their research career to studying biological phenomenon, demonstrated considerable variability in their topics of study and in their educational preparation. In addition, they were very consistent in detailing their use and benefit of mentors and collaborators, primarily in disciplines outside of nursing. They were also consistent in their advice to new investigators to find good mentors. A majority continued to find tension between what they study in the biological realm and what they feel some nurses define as “nursing science.” Their repeated advice to stay focused, work hard, and be persistent seems to reflect how to succeed in the research arena, rather than anything specific to do with the nature of biological research.

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