Impacts of an Undergraduate Research Assistant Program: The First Decade

Sharon Smith (srsmith@connecticutchildrens.org)
University of Connecticut School of Medicine
https://orcid.org/0000-0003-0571-1787

Adrienne Nguyen
University of Connecticut

Danielle Chenard
Connecticut Children's Medical Center

Kristin Burnham
University of Connecticut

Arlene Albert
University of Connecticut

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Abstract

Purpose

There is a declining number of physician-scientists. Little is published about the potential for undergraduate student experiences to contribute to the pipeline of future researchers. The purpose of this study was to describe a unique undergraduate research program and report the outcomes of the first 10 years.

Method

The Undergraduate Research Assistant Program (URAP) was described including course content, research experiences, and student composition. Outcomes of URAP student contributions to the literature and research presentations was reported. URAP students were also surveyed to assess their perspectives on the impact of the URAP program on career choices after graduation.

Results

URAP began as an independent study course and grew into for-credit undergraduate college courses. There a total of 212 students have taken at least one semester and 88 responded to the survey. All students who attended URAP have graduated, and 77% (n=68) reported the URAP program prepared them to reach their career goals. Most graduates pursued health care careers including medical school (55%), Master’s programs in health care (29%), or PhD in health care (5%). URAP students participated in research involving 11 different pediatric subspecialties. Many attained co-authorship of abstracts and publications, 53 first-authored an abstract presentation and 7 manuscripts.

Conclusions

URAP significantly impacted undergraduate students who overwhelmingly entered health care fields. While difficult to assess if these early experiences will influence participation as future physician–scientist, these students made meaningful research contributions while enrolled in these courses.

Introduction

Physician-scientists serve a vital role in bridging the gap between health research and patient care. The Institute of Medicine and the National Institutes of Health (NIH) have documented declining numbers of physician-scientists as well as the loss of potential investigators during career training. Thus, there is a need for training researchers in both clinical medicine and in research methods.

Early exposure to research is correlated to future participation in research endeavors. Several studies evaluated the impact of involving medical students in research. These students were more likely to engage in research during their careers than students without this experience.[1–3] This is further supported by a meta-analysis that documented positive correlations between medical-student research
participation and participation in future research activities.[4] Research experience in the undergraduate setting can provide the framework needed for admission into graduate school and future employment considerations. While little has been published on the impact of undergraduate research programs on developing physician-scientists, a few programs demonstrated an increase in health and STEM careers after undergraduate research participation.[5–8]

The Undergraduate Research Assistant Program (URAP) at the University of Connecticut was established in 2008 to support research education activities. With support of Connecticut Children's faculty and staff, URAP evolved by training a workforce designed to meet the organization's clinical research needs. The pathway into research for undergraduate students was initiated in response to their desire to engage in clinical research programs. This program can serve as a model of cooperation between an undergraduate university and an academic hospital. It was designed to enhance undergraduate basic science education with practical clinical research experience. Furthermore, students participate in existing research programs which allow them to learn how research issues are addressed in real-time. In this paper, the development and content of a clinical research course is described. It is anticipated that participating students will be inclined to pursue clinical research during their careers. To assess the impact of URAP on student development a survey of former students was developed to determine their perceived benefits from the course, the impact on career choices and subsequent research participation.

**Materials And Methods**

**Course Development**

The program consists of two sequential three credit honors-level courses offered through the Department of Molecular and Cell Biology. Within each course, our faculty employ active-learning techniques. In the first course “Introduction to Translational Research” undergraduate students attend weekly lectures presented by principal investigators of on-going clinical research projects. The biological principles underpinning current clinical research questions are presented during these lectures. Each week the two-hour lecture period is coupled with clinical hours when students can be on site for a clinical rotation. The lectures and discussions allow students to relate their background in the basic sciences to clinical research problems. The onsite location is based within the Emergency Department (ED) at Connecticut Children's, a Level 1 Pediatric Trauma Center that provides care to more than 65,000 children each year. In addition, there are experiences in the Pediatric Research Institute which provide a full array of appropriate opportunities for the students. Studies are presented that address topics appropriate for undergraduate classroom discussions such as diabetes and nutrition. The first semester curriculum also includes discussions of research methodologies and the basic-science underpinnings of current clinical studies. Lectures are used to train students in the principle methods of clinical research. These include study design, sample size calculations, inclusion/exclusion criteria, data collection and enrollment techniques. Students perform administrative support duties related to the collection of clinical data and/or the coordination of clinical studies. The URAP students provide administrative support for the faculty,
including managing data input, obtaining consent, and participating in study meetings. By performing a wide range of duties, students learn the importance of accuracy, data cleaning, and basic analyses.

In addition, students are prepared to become actively involved in clinical research in the hospital. The students are required to complete the Collaborative IRB Training Initiative (CITI) which is an educational program for the protection of human subjects in research. Once completed, students are able to administer informed consent with study participants. This involves giving a subject information concerning the study, providing opportunity for the subject to consider all options, and responding to the subject's questions, ensuring that the subject has comprehended this information. Students’ understanding of a disease or clinical problem and research methods is necessary to explain studies and answer questions of children and their parents. Students also collect data from patient history and from physical examination findings. During the training process, students learn to effectively interact with patients through classroom role play practice of approaching patients and enrolling subjects. Upon initially entering the hospital setting an apprentice model is used to further develop each new student’s competence, confidence, and independence as research assistants. Each student is mentored one-on-one by an experienced research assistant, research associate, the project Principal Investigator (PI), or a course director. All students are under the supervision and oversight of the on-duty emergency medicine faculty when enrolling patients. Over the course of the semester students perform clinical rotations which are comprised of four-hour blocks per week.

The subsequent URAP course, “Clinical Research Laboratory” was developed in response to the desire of many students who had successfully completed the introductory course to continue participating in clinical research. These students typically focus on a specific study. In addition to enrolling study participants they take on additional research responsibilities such as maintaining study documents, performing data entry, monitoring enrollment goals, and identifying practical challenges. Some of the students made study packets, developed study-related information handouts, entered and cleaned data, and made follow-up telephone calls. Students typically form an apprentice type partnership with the primary investigator to solve study related problems. These students may assist new students to effectively engage in the research. Additionally, regular meetings with members of the research staff and other senior students address challenges presented by the study project. This course is often repeated for credit by students deeply engaged in a project.

Knowing how to write a research paper is a valuable skill that will serve students throughout their careers. To this end students in both courses are required to keep a journal of their experiences in the hospital and to record their research progress. This gives instructors feedback throughout the semester. It also serves the students in that they learn to express concisely and accurately their observations. At the end of the semester students in the first course are required to write a research paper on a medically relevant topic of their choice and to prepare an oral presentation. Students in the second course prepare a paper and present a talk on their specific project.
Throughout both courses students are required to engage in self-directed reading about underlying
disease processes and clinical problems. When applicable, they learn about the basic science
underpinnings that support the clinical studies. Through this program students are enabled to function as
research assistants in a busy urban pediatric emergency department or in associated departments. The
overwhelming popularity of these two courses has led to the creation of a 10-week volunteer summer
session which functions as an introduction to, or a continuation of, both courses.

Student Cohort

URAP attracts pre-medical and pre-dental undergraduate students. Students enroll in URAP courses
during their junior and/or senior years. Enrollment is limited to the number of students appropriate for the
capacity of the participating hospital departments. The number of students who participated in the
introductory URAP course between 2008 and 2018 ranged from 8–15. Typically, the maximum number of
new students was capped at 12. This was necessary for appropriate training and scheduling.

Survey of URAP Impact

A survey was designed to determine the potential impact of URAP on the research accomplishments and
the career paths of students. This survey used concepts from Cook and Beckman. The survey solicited
student opinion of the URAP course, the impact on their careers, and their accomplishments since
graduation. Objective survey items included demographics, year of graduation, number of semesters in
the program, and reported research outcomes such as abstract submissions and presentations,
manuscripts, and authorship. Some items asked for student perception of the importance of URAP on
their career choices and subsequent research participation. For example, one item was “How does the
value of the URAP program compare to your other undergraduate courses/ internships?” The response
options were the most valuable undergraduate course, much more valuable than other courses, more
valuable than other courses, less valuable than other courses, and prefer not to answer. These items were
designed to capture the perceived research benefits as self-reported by graduates from URAP.

Survey items were piloted, revised and Institutional Review Board permission was obtained. The Qualtrics
data system was used to create and administer the survey. Students who participated in one or more
semesters of the program were included in the survey. A link to the survey was sent by email to all former
URAP students whose names and email addresses were obtained from the university registrar or from the
Alumni Office. Many former students are enrolled in an educational program such as graduate school,
medical school, residency, or fellowships.

Student Productivity

The contributions of URAP students to active clinical research programs were determined. These
contributions were reflected in the number of studies URAP students participated in, the number of
subjects enrolled by URAP students, and the number and type of clinical departments involved. Each first
semester URAP student participated in 3–5 studies; second semester students typically focused on one
study. Enrollment in several of these studies extended over multiple semesters. Student assistance in
patient enrollment represents significant support for a clinical study. Emergency Department based studies occasionally were in collaboration with other pediatric subspecialties. This resulted in greater than 10 different subspecialty collaborations that included URAP student participation.

In addition to advancing programs by gathering data a number of students made sufficient contributions to various research programs to warrant co-authorship on abstract presentations and on publications resulting from their work. These students were deeply committed to the project and their contributions extended beyond patient enrollment. Table 1 shows the number of abstracts, author order, type of abstract presentation (poster or platform), meeting, and number of manuscripts and author order for the first decade of URAP. Additionally, presentations were given at sub-specialty meetings such as otolaryngology, local meetings, and university events. As URAP matured the number of students who developed their own research study increased as indicated by first author position.

Results

The objective of URAP is to support the career goals of students and to prepare them for careers in medicine or the biomedical sciences. While the program has had an impact on the research programs of clinical researchers as noted in Table 1, it is important to address the student assessment of the program on their career preparation. To this end, a survey was developed to assess the impact of URAP in both objective measures of research productivity such as publications and presentations and on student perception of the value of course preparation.

The total number of URAP students in the first semester course grew slightly and then maintained enrollment over the ten-year period. Participation in the senior course varied slightly over time but was higher in the spring semester in most years. The survey was sent to all prior students (N = 212). A total of 88 students (42%) completed the online survey. The students reported themselves as 59% women and 62% White, 1% Black, 31% Asian, and 6% other/mixed. There were no responses from students who took URAP in 2008 or 2009 and the other years had a range of responses from 5–23% with most years representing about 11% of the sample. Students who took URAP in 2017 had the largest number of respondents for a given year. Approximately a quarter of respondents took URAP for 1 or 2 semesters while 39 (44%) took 3 or more semesters.

The URAP courses were regarded as extremely positive by students. Students reported that the courses provided appropriate supervision (94%) and instructor feedback and evaluation (92%). Most undergraduates planned on post-graduate education (n = 51, 58%), or a gap year prior to graduate education (n = 26, 29%). For the students planning gap years approximately 50% planned one year. The undergraduates regarded the URAP courses as valuable preparation for post-graduate careers/education with 77% (n = 68) reporting that the URAP program made them extremely more or much more prepared to reach their career goals.

Students who pursued post-graduate education overwhelmingly remained in health care careers. This was not unexpected because the course attracted students on the healthcare track. Of all the graduates
who reported post-graduate education (n = 39), 55% attended medical school, 29% attended Master’s program in health care including physician assistant programs, 8% Master’s in STEM field, 5% PhD in health care field and 3% PhD in non-healthcare or STEM fields. Of the 7 who reported being in residency or fellowship, there was one each in internal medicine, family medicine, emergency medicine, pharmacy and 3 who entered pediatrics.

Of the students responding (n = 88), 35% took a gap year after graduation. For students who took gap years (n = 31), 38% took one year, 29% two years, and 29% took greater than 2 years. During their gap years a majority of students participated in research or in healthcare. For those who took gap years, 62% reported working in research, 15% in public health (ex. Teach for America), 15% in health care, while 6% reported traveling and 3% working in non-healthcare jobs.

In addition to teaching research principles and providing clinical research experiences, URAP encourages students to develop their own clinical research projects. Learning may best be achieved by active engagement through reading, writing, discussing, and problem solving.[10] Experiential learning is acquiring knowledge and meaning through real-life experiences.[11, 12] Therefore, the senior level course incorporated self-study, a flipped classroom, workshops, participant presentations, and skills for conducting research. Involving students as collaborators on a research team exposes them to the practical challenges of clinical research. This experience gave students the confidence to analyze data from one of the larger datasets such as Pediatric Hospital Information Systems (PHIS). Students were enabled to ask their own research questions and develop their own projects. About 15% of upper level students developed their own study and were mentored by CT Children’s faculty. Pre-existing databases, large data sets, and electronic medical records are frequently used as data sources for research. Other students developed survey studies based on their reading, literature review, and mentor input.

In addition to developing new hypothesis and research questions students engaged in data clean-up and analyses. Thus, some students became first-author on abstract presentations (Table 2). Many URAP students have presented their first author abstracts at regional and national meetings (Table 2). Some students were such an integral part of the projects, they were included as co-authors[13–16] or first authors.[17–23] Important outcomes of the undergraduate research projects are demonstrated in their co-authorship of a large number of abstracts and publications, but most impressive are the numbers of first-authored abstract presentations (53) and articles (7). URAP students have participated in ED-based studies that consist of collaborations with more than 10 different subspecialties, including pediatric hematology, pediatric surgery, trauma, pediatric orthopedic surgery, pediatric cardiology, and pediatric dentistry.

Discussion

Much of medical education involves mentoring in an apprentice-like environment. Many learning theorists believe that “learners have to be actively engaged within their surroundings if they are to gain applied knowledge.”[12] Active learning that is driven by the individual student's needs and learning styles has the
greatest impact on knowledge acquisition. A meta-analysis of 225 studies comparing traditional lectures to active learning in university STEM courses found that active learning significantly increased students’ knowledge and decreased failure rates.[10] The biggest effects were noted in students from underrepresented backgrounds and in the context of small class sizes. The United States President's Council of Advisors on Science and Technology in 2012 reported on the positive effects of active learning over traditional classroom approaches and lectures, noting that students learned twice as much through active learning.[24]

Summer undergraduate programs are often good introductions to clinical research and keep projects active during the summer months. Authors at the University of California Irvine described a 10-week summer course over a 3-year period from 2004-07 that included lecture series and development of projects in biological and social sciences.[25] This study showed increased satisfaction compared to students participating in other summer fellowship programs and improved attitudes about working in interdisciplinary teams. Analogous short-term summer research training for medical students has been shown to significantly improve research self-efficacy. One study evaluated three separate NIH-funded medical-student summer programs, two focused on adult diseases and one any research topic.[26] All three resulted in similar improvements in the areas of research methodology, communication, regulatory, and organizational skills. These programs provided actively mentored research experiences combined with didactics.

It is difficult to determine the influence of undergraduate experiences on an individual’s participation in research after matriculation from medical or graduate school. However, it is reasonable to anticipate that positive undergraduate research experience will instill excitement to pursue scientific inquiry. The URAP survey suggests that these early student experiences in clinical research were extremely positive. Most students who completed URAP and went to medical school are now in residency or fellowship. Future contact may show involvement in research as part of their careers. The University of Connecticut, like many medical schools, currently requires all medical students to develop their own research (capstone) projects. URAP provides a foundation for this requirement. Longer-term impacts of introducing research early in medical education were evaluated by a study of Duke and Stanford medical students who had required research added to their third-year curriculum.[27] Students were evaluated yearly and through their first post-graduate year. Ninety-five percent of medical students rated their experiences as positive, and half as “excellent.” Long-term data on final careers have not yet been released; however, prior to their experience, 71% of these students reported interest in pursuing a career in academic medicine, compared with 81% afterwards, and 87% reported that this research experience influenced future plans. These results are consistent with other published studies documenting that early, dedicated research experiences are associated with choosing careers in academic medicine.[7, 8, 28–30]

**Conclusion**

The Undergraduate Research Assistant Program is a robust program that integrally involves, highly motivated undergraduates in clinical research. The focus on experiential learning and mentorship creates
a community where undergraduates develop as researchers, authors, team players, and leaders. These skills will not only benefit the students themselves in their professional careers but will also contribute to the betterment of the larger clinical and scientific community, enabling us to better serve the people and patients under our care.

**Abbreviations**

URAP  
undergraduate Research Assistant Program

**Declarations**

**Ethics approval and consent to participate**

The Connecticut Children's Institutional Review Board permission was obtained prior to starting the survey portion of this study, permission number 17-157.

**Consent for publication**

Not applicable. There is no personal or identifiable information presented.

**Availability of data and material**

Authors can provide the survey data to editor or peer reviewers at any time. Much of the data is presented in the article.

**Competing interests**

The authors declare that they have no competing interests.

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Conflict of Interest

None of the authors have any conflict of interest related to this study.

Author Contributions

The author contributions: SR Smith and A Nguyen made substantial contributions to the conception and design of this work, acquisition of data, analyses of data, drafting and revising the manuscript, and the final approval. D Chenard and K Burnham made substantial contributions to the conception and design of the work and surveys, acquisition of data, and critically revising the manuscript. A Albert made substantial contributions to the conception and design of the study, drafting and critically revising the manuscript and provided final approval for publication. All authors are accountable for the accuracy and integrity of this work.

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