THE EUROPEAN EDUCATIONAL RESEARCHER
DOI: 10.31757/euer.214

http://www.eu-er.com/

Independent Research as a Resident Physician: Novel Methods for Data Collection, Teaching, and Collaboration During Graduate Medical Training

Reza Hosseini Ghomi, Sarah Holden, Aaron Ong, Akanksha Bawa, Ali Rafiq, Aparna Hariprasad, Christian Buensuceso, Emily Nguyen, Enoch Chung, Goda Lajauskaite, Hirali Kadakia, John Kim, Kaylani Tam, Kendra Leete, Kielan Lemoine-Kowalski, Kimmie Bacon, Lana Shamdeen, Nadav Brumer, Nikolai Liang, Yasmin Byott, David Atkins, John Neumaier

University of Washington, USA

Abstract: Since the mid-1990s, the US has seen a decline in research activities in medical education and academic health care centers. Our goal was to offer a multi-disciplinary experience for undergraduates to participate in a practical, hands-on research experience to increase the likelihood of entering STEM research careers. The authors structured a collaborative teaching environment to lead a group of over 25 undergraduate and graduate students in clinical research activities as part of the resident author's research program during psychiatry graduate training. A particularly innovative component of this work, making the timeline and technical analysis possible, was the partnership with an industry sponsor. Much of the teaching program's structure was inspired by the analogous program of the industry sponsor. This provided a structured clinical research experience for undergraduates, providing opportunities to participate in the study design, patient recruitment and enrollment, data collection and analysis phases of the project with more autonomy than typically available at this level of training. Students favored the experience with generally positive ratings of the program. Students gained skills and felt more comfortable in practical aspects of research and stated they were more likely to pursue a research career after this experience. This method may be a solution for other clinical trainees given their limited time and funding while serving to increase exposure to STEM research earlier in life to reverse the trend of declining research activity. This method can be used across other training institutions at different scales to achieve similar goals.

Keywords: *Industry collaboration; Medical Education; Trainee research; Undergraduate teaching*

Introduction

We describe a solution here addressing teaching, research, and clinical work for investigators. I chose to pursue my own research path during my research time in residency. This brought with it many challenges making successful completion of a project difficult. I found myself interested in research, clinical work, and teaching at a time when many career paths choose a single focus. In order to obtain experience across all three domains I needed a plan given my limited funding and time.

As the lead investigator of an independent research effort during my psychiatry residency I was faced with numerous challenges: 1) data collection can be expensive and often research funding covers only trainee time and not the study staff needed for data collection, 2) academic systems often limit independence by allowing trainees to work only under a supervisor within their research framework, and 3) time is a limiting factor for data collection given the clinical demands on trainees.

Since the mid-1990s, the US has seen a decline in research activities in academic health care centers. Between 1984 and 2001, research activities among academic medicine faculty fell from 29% to 14.7%. At least some of this trend is likely driven by legislative and funding decisions at the national level and secondary to economic pressures. However, here we focus on addressing factors more readily modified at

the individual level. Without clinical research, discoveries made in basic and translational research cannot be tested or applied to patient care (Meador, 2015). It is critical to address the deficit in clinical research being conducted in the US by first addressing the deficit in skilled clinical researchers. One strategy is to provide experience during the undergraduate curriculum. Undergraduate medical students who are exposed to practical research activities are more likely to pursue research-related careers(Solomon, Tom, Pichert, Wasserman, & Powers, 2003) and become physician scientists (Fang & Meyer, 2003). Previous work has helped identify differences in motivation between students planning to pursue a clinical practitioner career vs. those interested in answering scientific questions (Pacifici & Thomson, 2011), allowing for a multifaceted approach to best utilize all students.

The concerning decline in medical academic research also likely has an origin at the trainee level. Trainees do not typically obtain grant funded or lead grant funded studies. However, clinical training years are a crucial period for exposure to research. Facing the completion of clinical training, modern day residency graduates are often facing the increasing burden of student debt and, in many cases, the need to provide for their families. In the face of opportunities for industry or clinical roles that offer generous compensation and stability, these factors, make an academic research career less and less attractive (Huisman, de Weert, & Bartelse, 2002; Roach & Sauermann, 2017). Add to this the difficult and thankless task of grant-writing (there is a significant learning curve for grant funding requiring trainees to weather numerous unfunded applications on average), many of these factors negatively deter trainees from gaining exposure to research during their training.

The decline in research activities is a problem that has affected multiple disciplines and specialties. The number of clinicians who have research questions and interest in teaching vastly outnumbers the funded positions for research and teaching. This solution is meant to provide an avenue to anyone wanting to pursue a research path with limited time and funding.

Additionally, a significant amount of data resides outside of academic environments, and for this project, the data needed was patient audio recordings, data that is not part of the medical record. I refer to data here as any information collected within the clinical interaction.

Once I chose to pursue an independent research path requiring de novo data collection, I had limited resources to do so and, therefore, limited solutions. Of course, I could have worked with existing data and under more direct mentorship in an existing lab and this would certainly benefit many trainees. Having previous research and teaching experience, I felt I was ready for the next step of independence and strove to provide a clinical experience for undergraduates which was more than just shadowing. Students while shadowing do not gain firsthand experience and do not benefit from the one on one patient interaction, missing opportunities for problem solving, empathy, and rapport building which strongly inform the desire to pursue clinical work as a career (Davis, Anderson, Stankevitz, & Manley, 2013).

The idea to create an undergraduate clinical research elective experience was conceived for several reasons:

a) The need for a feasible research study design to collect data at scale otherwise inaccessible for a resident physician led investigation, b) provide a comprehensive research experience to undergraduates allowing them to take on leadership roles, c) inspire motivation for undergraduates to consider careers in science and technology, d) demonstrate how to navigate clinical medicine to conduct research, and e) provide a therapeutic encounter for patients during the research visit, especially for underserved patients.

Specifically, our research aims were focused on developing voice-based models of neuropsychiatric disease in order to develop digital biomarkers to screen, diagnose, and manage these diseases. For example, a depressed patient may have certain features in their voice such as changes in their tone, pauses between words or sentences, or words they use. These changes, when tracked across large numbers of patients, can be quantified to a much finer degree than historically possible using machine learning techniques. These voice markers can then be used to build a model of depression based on audio and linguistic features to detect the presence of depression and even the severity. There are number of previous studies validating this connection between voice and disease which is outside the scope of this work and discussed in our separate articles (Pittman, Ghomi, & Si, 2018; Wroge et al., 2018).

Our work, collectively named "Project Echo," is an independent study program designed to equip undergraduate students with the skills necessary to conduct research in a clinical setting. Here we describe the development of the Project Echo curriculum, the types of studies students conducted, and the unique skills students gained by participating in the program. We evaluate how the program increased students' capacity for participating in clinical research, likelihood of pursuing further research, and how it impacted their educational and career goals. Students had the unique opportunity to work closely with medical administration and to work independently to create research tools. Students' perception of self-efficacy in research is directly related to their likelihood of pursuing a research career (Adedokun, Bessenbacher, Parker, Kirkham, & Burgess, 2013). A major goal of our approach is to increase research skills and therefore increase the perception of self-efficacy resulting in increased likelihood of pursuing research careers. In addition, the goal was for a similar model to be easily implemented by trainees at any institution to achieve similar results.

Methods

Here we describe specific methods by which we chose to pursue our research and teaching agenda. This paper discusses the methods involved in carrying out the teaching curriculum while there is the overarching research agenda, we discuss the specifics of the research and related science in other articles. Here we are only concerned with the layer of student and trainee involvement and strategy to conduct research with limited research. Much of this approach was inspired by previous work including by Schwoebel at Georgia Tech (Fasse et al., 2013). Schwoebel has adapted his previous teaching into a research fellowship program referred to as the "Tribe Program" internally at his company, NeuroLex Laboratories. Adapted to a university setting for this project, students had the option to enroll in and receive elective course credit they could use toward satisfying their undergraduate requirements. This was a major

incentive made possible because of the psychiatry training program's affiliation with a university.

Recruitment

Student were recruited via an ad posted to the university's job listing website. This is the primary location for any internship or job posting for the university. All student from all backgrounds were welcome. Over the course of approximately 4 weeks, I received approximately 180 applications for the position of research fellow. It is important to note the university within which my residency program resides is large, consisting of approximately 32,000 undergraduates at the time I posted the research opportunity. I screened applications based on general criteria such as grade point average, previous course work, and interest and motivation to pursue the work. I conducted approximately 70 interviews in person consisting of about 10-15 minutes each to both ask the applicants questions targeting their comfort and ability to be self-driven and interact independently with patients. I also explained the expectations of the position at this time and answered any initial questions. I selected the 26 research fellows from this stage mainly based on their ability to commit to the requirements of the work and the alignment of their goals and interests with what I was able to offer. All students were adults; no minors were included in this work.

Students were expected to commit a specific number of hours per week depending on the number of credits they enrolled in (e.g. 3 hours per week per credit) with a minimum of 3 hours per week in order to remain fully engaged. Primary criteria for participation were based on completion of weekly objectives, completion of survey tools, review of patients recruited, participation in meetings, etc. Students also rotated giving weekly presentations to the group based on their literature review and learning regarding their specific disease area and the impact of voice and speech by the disease.

Meetings

We chose to hold mandatory weekly meetings in order to coordinate among the large number of students involved. The agenda was flexible in order to maximize open dialogue needed at varying degrees depending on the stage of the project. Students started meetings by discussing their weekly achievements and challenges, connecting back to the goals they had set at preceding meetings. Meetings provided an opportunity for students to ask questions, seek guidance, and update the principal investigator. About four months into the study, we organized a group retreat in response to feedback from students who desired more meaningful opportunities to interact with their peers. For this I chose to involve a psychologist with team coaching experience (Gareth Holman, PhD). At this retreat we completed several team-based exercises which were received well and served to align students' values and perspectives. The leadership and guidance of an expert during the retreat was critical. Student feedback following the retreat reflected success in accomplishing the goals of providing more alignment and grounding in the underlying values driving the research, namely to develop safer, faster, cheaper, and easier to use biomarkers for patients.

Data Collection

During our study, we conducted brief interviews with patients and recruited from various clinics both in person and remotely using existing research registries.

In preparation for collecting data, students were tasked to create the survey tools to capture the data of interest. This involved literature reviews of studies focusing on voice and its relation to neuropsychiatric diseases. In our case, further independence was provided to the students to choose their area of focus resulting in 13 total diseases of interest. These included: Depression, Anxiety, Parkinson's Disease, Alzheimer's Disease, Multiple Sclerosis, Traumatic Brain Injury, Autism, Borderline Personality Disorder, Psychosis, Bipolar Disorder, Post-Traumatic Stress Disorder, Stroke, and Amytrophic Lateral Sclerosis. A common questionnaire was used to capture demographics and other confounders of voice signal (e.g. have you ever smoked) commons across all studies, with students creating the disease related portion to include targeted questions such as the Patient Health Questionnaire-9 for depression. 26 students paired together to form 13 teams to cover all diseases. The students worked together to perform their literature reviews, present their results to the group, and build their study questionnaires, and test them for length and completeness.

Students were also tasked with creating partnerships with different clinics in order to establish sites to collect data. The goal of this task was to encourage students to learn how to coordinate with hospitals, clinics, and communities to form relationships allowing them to collect data with their populations. Tasks included scheduling on-site clinic time, scheduling with patients, and frequent communication in person, phone, and email with staff. Students branched out beyond the home institution's available clinics to recruiting from local and national communities. This advertisement was accomplished using online communities such as Mental Health America's website and local events such as the Autism Speaks local annual event and several local community mental health clinics among others.

The principal investigator provided as many live demos with patients for the students as requested and once comfortable, students worked independently and in small groups to speak with patients to collect data.

Of note, data analysis was facilitated by our partnership with NeuroLex Laboratories, a voice technology company, who was able to share expertise and assist with data analysis. This facilitated technical research with limited funding and made this study possible. This partnership was incorporated via a data use agreement through the host university's office of sponsored programs and overseen by the university's internal review board. In terms of ensuring data integrity and attempting to remove bias due to this relationship, all data analyses were independently completed and reviewed by students and faculty without the industry relationship. The project PI, Dr. Hosseini Ghomi did not participate directly in patient recruitment or enrollment.

Student Surveys

A cohort of 26 undergraduate students from the University of Washington representing 10 majors participated in Project Echo, and 21 completed an anonymous online evaluation after completion of the program. Data collected include demographics, students' reflections on skills gained from the program, and whether their inclination for clinical research has changed over the course of Project Echo. The 5 students who did not complete the survey consisted of 3 students who did not respond after

completing the full program and 2 students who did dropout of the program before the completion of research activities. In both cases students submitted hardship withdrawals.

Importantly, the survey assessed the change in students' goals, comfort with patient interaction, networking abilities, and interest in research. The survey was created and distributed through Qualtrics. The survey itself and full dataset are available in the appendices or online at the link included below in the data availability section.

The technical content of the research work as it pertains to building predictive models of disease using voice and other digital biomarkers is discussed further in separate publications and is ongoing (Pittman et al., 2018; Wroge et al., 2018).

Results and Discussion

This experience provided a comprehensive research experience during clinical training and addressed several challenges faced by trainees: namely, lack of funded staff, lack of sufficient funded time, difficulty collaborating across departments, challenges with aspects of studies such as data science. In this case I was able to build collaborations across several departments at my university including computer science, biostatistics, electrical engineering, and the Information School. We also were able to take advantage of an outstanding resource somewhat unique to The University of Washington: the eScience Institute, a multidisciplinary data science initiative at the university which offers expertise across many domains as well as many opportunities for training and collaboration. Collaborations with undergraduates, graduate students, post-docs, and faculty have allowed me to address gaps in expertise that arose during the project, particularly in the areas of data science, statistics, signal processing, and hardware. These relationships additionally benefitted the educational experience of the undergraduates participating in this project, allowing them to gain exposure to various backgrounds and expertise, and in turn, accomplish research goals and gain insight into future possible STEM (Science, Technology, Engineering, Mathematics) careers. Specifically, the students from this project came together and collaborated with graduate students from the information school at UW to assemble a poster describing their research and initial results of using voice features to model several different diseases. This poster was presented at the annual undergraduate research symposium hosted every spring at UW.

Regarding the undergraduates who participated in this experience, many indicated they were pre-health (76%), and that patient interaction was an important part of their undergraduate education. Of the group, ⅔ were psychology and biology majors. Student goals included: gaining clinical research experience, one-on-one patient work, networking with medical professionals, and data analysis experience.

We assessed the impact of patient interaction through clinical research and found that students reported that they became significantly more comfortable working with patients due to this experience (paired $t = -9.44$, $p < .001$). Students scored their preparedness before the project on a scale of 0-10 an average of 6.2 ($n=21$, $SD = 1.3$). After the project they reported feeling a preparedness score of 8.8 ($n=20$, $SD = 1$).

91% of the students had interactions with medical administrators, 81% of students felt "probably or definitely yes" that their professional network expanded throughout the experience. In terms of feeling they had an increased likelihood of pursuing research, students reported an average score of 8 (SD = 1.8). Ethnicity was a significant variable in mean satisfaction levels, but the sample size was too small to draw any conclusions. Students responded favorably to weekly meetings, with a mean rating for comfort in asking questions of 8.9, SD = 1.1, and a mean rating for comfort in sharing updates of 8.5, SD = 1.3. The structure of weekly meeting had a mean rating of 7.9. While initially uncomfortable working with patients, students enjoyed their patient-researcher interactions, with a mean positivity rating of 8.6. Students rated their overall research experience as 8.6, SD = 1.8.

We did not find a significant association between students who had a positive experience and those who wanted to pursue research in the future. There was no significant association between students who were more comfortable with asking questions and those who had a positive experience. There was no significant association between comfort ratings (asking questions and giving updates) and perceived effectiveness of weekly meeting structure. There was no significant association between degree of comfort with patients and overall one-on-one experience working with patients and students were still able to have positive experiences despite not being comfortable. There was no significant difference in mean satisfaction levels based on gender. 7 students stated they had difficulties with establishing relationships with clinics to collect data.

Qualitatively, challenges the students faced included variation in study population size. Some students were collecting data from common diseases, whereas others were collecting from rare diseases, making recruitment much more challenging. Students also cited restrictions at the clinic level (clinic protocols) increasing the difficulty to recruit as well as the difficulty in retaining patients. Our success continues with ongoing publications including our first with a Parkinson's Disease data set (Pittman et al., 2018; Wroge et al., 2018).

Quotes from students regarding the impact of this experience on their goals include: "a little more solidified to do something in the health field", "I would consider a research job instead of pursuing a medical doctorate now", "I found that I am less interested in doing research as a career", "this experience has made me much more confident about what I want to pursue post-undergrad", "opened me up to possible career paths that don't involve me directly going to medical school and becoming a doctor.", "more inclined to pursue research in my future career!", "confirmed my desire to pursue medicine."

Given the boot-strapped approach of this research and teaching model requiring minimal resources other than access to undergraduates or other students willing to participate and a clinical environment to allow research activities, this effort can likely be replicated at other institutions. The main resource used here was time with no other direct costs of the research itself. We were able to use space and equipment provided by the academic institution and participating clinics without charge to conduct this work.

Conclusions

We presented an innovative method to accomplish research via partnerships with industry, academic, and non-profit partners. Specifically, we partnered with an industry partner, NeuroLex Laboratories, providing expertise in voice technology. Our non-profit partners included Mental Health America, National Alliance for Mental Illness, Autism Speaks, and several others. All of these organizations have massive networks with hard-earned relationships and very generously provided their support in helping us collect data by connecting us to their communities. This method can be difficult to replicate if these partnerships are not available or if the trainee's home institution is not familiar with facilitating these partnerships.

Limitations of this work included failing to attract more diversity among students. Our students represented several ethnicities including Caucasian, Asian, and "other", but we did not have students who self-identified as "black or African American", "American Indian", "Alaskan Native", or "Pacific Islander".

The effort required to carry out this project was significant and may perhaps be facilitated better with assistance from more medical trainees. As a sole principal investigator, I felt over-stretched and found it difficult to meet the requirements of the work at times. The rewards and accomplishment achieved, however, outweighed these challenges.

Our goal was to not only provide education but address the falling numbers recruited to research careers, especially in academics. Based on the student feedback and keeping in mind this study did not follow students years ahead to evaluate true impact, we do believe student identities as researchers were significantly boosted with several expressing they felt more resolve and solidification with research as part of their identity. We believe this is ultimately a primary driving force in carrying someone into a research career.

Acknowledgements: Dr. Hosseini Ghomi wishes to thank Dr. John Neumaier and Antronette Simmons for their research support. David Atkins served as the research mentor during Dr. Hosseini Ghomi's residency and his guidance was critical to the experience and ability to pursue research goals. The author also wishes to thank all the undergraduates for going along on this adventure with an open mind and the patients who participated in the studies for being willing to speak with students and share their stories.

Funding: Dr. Hosseini Ghomi's work was supported by NIH R25 MH104159 during the completion of this work. This funding provided protected time in Dr. Hosseini Ghomi's schedule and provided limited stipends for the research fellows. Dr. Hosseini Ghomi's work in preparing this manuscript was supported during his VA Advanced Fellowship Program in Parkinson's Disease which provided protected research time.

Competing Interests: Dr. Hosseini Ghomi is a stock holder of NeuroLex Laboratories.

Ethics approval and consent to participate: This work was approved and overseen by the University of Washington IRB, study #00790. Initial approval was granted on 12/23/2016. All patients who participated in this work were required to complete a written informed consent process as part of our IRB approval.

Availability of Data and Materials: More details regarding the structure of our undergraduate and graduate fellowship program and curriculum and the survey tools used in this work can be found at: https://github.com/jim-schwoebel/tribe

Authors' Contributions: RHG was the principal investigator and wrote the manuscript. KLK, SH, AO, AB, AR, AH, CB, EN, EC,GL, HK, JK, KT, KL, KB, LS, NB, NL, YB all helped with building the survey tools, recruiting and enrolling patients, building the post-study survey, analyzing results, and preparing background and other sections of this manuscript. DA was the primary mentor for this research and provided editorial guidance and JN provided funding support for this work. All authors read and approved the final manuscripts.

References

Adedokun, O. A., Bessenbacher, A. B., Parker, L. C., Kirkham, L. L., & Burgess, W. D. (2013). Research skills and STEM undergraduate research students' aspirations for research careers: Mediating effects of research self-efficacy: RESEARCH SKILLS AND STEM UNDERGRADUATE RESEARCH. *Journal of Research in Science Teaching*, *50*(8), 940–951. https://doi.org/10.1002/tea.21102

Davis, J. M., Anderson, M. C., Stankevitz, K. A., & Manley, A. R. (2013). Providing premedical students with quality clinical and research experience: the Tobacco Science Scholars Program. *WMJ: Official Publication of the State Medical Society of Wisconsin*, *112*(5), 195–198.

Fang, D., & Meyer, R. E. (2003). Effect of two Howard Hughes Medical Institute research training programs for medical students on the likelihood of pursuing research careers. *Academic Medicine: Journal of the Association of American Medical Colleges*, *78*(12), 1271–1280.

Fasse, B., Schwoebel, J., Craig, E., Joseph, A., Vakharia, A., Potter, S., … Linder, J. (2013). Developing Interdisciplinary Research Partners: The Learning by Innovative Neuro Collaborations Research URE. (pp. 23.403.1-23.403.27). Presented at the 2013 ASEE Annual Conference & Exposition, Atlanta, Georgia. Retrieved from https://peer.asee.org/19417

Huisman, J., de Weert, E., & Bartelse, J. (2002). Academic Careers from a European Perspective: The Declining Desirability of the Faculty Position. *The Journal of Higher Education*, *73*(1), 141–160. https://doi.org/10.1080/00221546.2002.11777134

Meador, K. J. (2015). Decline of clinical research in academic medical centers. *Neurology*, *85*(13), 1171–1176. https://doi.org/10.1212/WNL.0000000000001818

Pacifici, L. B., & Thomson, N. (2011). Undergraduate Science Research: A Comparison of Influences and Experiences between Premed and Non–Premed Students. *CBE—Life Sciences Education, 10*(2), 199–208. https://doi.org/10.1187/cbe.11-01-0005

Pittman, B., Ghomi, R. H., & Si, D. (2018). Parkinson's Disease Classification of mPower Walking Activity Participants. In *2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)* (pp. 4253–4256). Honolulu, HI: IEEE. https://doi.org/10.1109/EMBC.2018.8513409

Roach, M., & Sauermann, H. (2017). The declining interest in an academic career. *PLOS ONE*, *12*(9), e0184130. https://doi.org/10.1371/journal.pone.0184130

Solomon, S. S., Tom, S. C., Pichert, J., Wasserman, D., & Powers, A. C. (2003). Impact of Medical Student Research in the Development of Physician-Scientists. *Journal of Investigative Medicine, 51*(3), 149–156. https://doi.org/10.1136/jim-51-03-17

Wroge, T. J., Ozkanca, Y., Demiroglu, C., Si, D., Atkins, D. C., & Hosseini Ghomi, R. (2018). Parkinson's Disease Diagnosis Using Machine Learning and Voice. In *The 2018 IEEE Signal Processing in Medicine and Biology Symposium*. Philadelphia, PA: IEEE. Retrieved from https://www.ieeespmb.org/2018/papers/l01_01.pdf

Corresponding Author Contact Information:

Author name: Reza Hosseini Ghomi

University, Country: University of Washington, USA

Email: rezahg@uw.edu

Please Cite: Hosseini Ghomi et al. (2019). Independent Research as a Resident Physician: Novel Methods for Data Collection, Teaching, and Collaboration During Graduate Medical Training. *The European Educational Researcher, 2*(1), 49-58. Doi: 10.31757/euer.214

Received: December 10, 2018 ▪ Accepted: February 13, 2019