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Careers in Virology: Working at the Centers for Disease Control and Prevention

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Abstract

As non-academic careers in science have become less and less “alternative,” one field that has consistently attracted early-career virologists is public health research. The desire to make tangible contributions towards public health needs and better protect the public from infectious disease often motivate the transition. In this Career Gem, two academically-trained virologists offer insights into pursuing a research career in public health at the Centers for Disease Control and Prevention.

Traditional dogma would describe the ultimate goal of a scientific trainee to be the pursuit of a principal investigator (PI) position at a powerhouse, top-tier research institution. However, as the pool of graduate and postdoctoral trainees has continued to increase over recent years, so has a stark and somewhat somber realization that a limited academic job market and narrowing funding climate cannot possibly support an independent PI position for every early-career scientist (1-2). Fortunately, the past decade has also seen an increase in open dialogue and acceptance of “alternative careers” in science, those outside of the academic PI route. Even the term “alternative careers” has become a misnomer, as increasing numbers of early career scientists have pursued non-traditional careers and flourished in non-academic positions. Frankly, attempting to pigeonhole every scientist into a one-size-fits-all career path seems to impart a grave disservice. Encouraging individual strengths and passions within the many disciplines to which a scientific mind can be applied naturally fosters leaders and crosscutting innovation. One such field that is increasingly attracting early-career scientists trained in infectious diseases is public health research. In this Career Gem, we will highlight aspects of pursuing a career in public health research at the Centers for Disease Control and Prevention (CDC) from the point of view of two academically-trained virologists.

Infectious disease research at CDC

When considering the types of infectious disease research that might fall under the public health category, activities that likely come to mind may include investigating outbreaks and tracking viral emergence and evolution, designing new surveillance and

detection tools for use on the frontlines of disease defense, or developing novel or improved vaccines for domestic and global settings. Indeed, public health research by nature seems less an “alternative” career choice and more a natural extension of an infectious disease career path. It provides the framework for those who seek to bridge public service with applied research. In fact, most research scientists have carefully crafted a significance statement to highlight the “big picture” public health application of their work in a grant application, or underscored potential clinical applications during a seminar presentation or manuscript discussion. Such statements often reflect the very core of CDC’s disease-fighting research mission (3). What makes CDC different from many research institutes in academia, private industry, and other government sectors, is the immediate application of research to public health. The work of course is informed by and rooted in basic research, but the primary objective must directly advance or support a public health need. This unique focus often attracts those infectious disease scientists who have a desire to directly contribute to something more concretely on the public health spectrum, or perhaps to conduct research with a clear global impact. For many, the hook for making the transition from basic research to public health research is the potential to make tangible contributions towards concrete efforts that protect the country and often the world from infectious disease, whether it be by developing or evaluating new vaccine candidates, producing new diagnostic tools, or contributing surveillance data to track cases in real-time. Recent outbreaks of viral disease, including the re-emergence of Ebola and the ongoing Zika virus epidemic, continue to bring to the forefront the need for experts in infectious diseases to be engaged in public health research. However, since research scientists are primarily trained in academic

92 settings, it is often a mystery as to how research at a public health institute like CDC
93 might look and feel, and how one might make the transition from academia to public
94 health.
95
96 **Transitioning to CDC**
97 Opportunities for research in viral infectious diseases at CDC are vast, from models of
98 viral pathogenesis and transmission, to antiviral and vaccine development, to
99 surveillance of viral emergence and population immunity, to tracking viral spread and
100 epidemiology. CDC scientists have a multitude of training backgrounds (e.g., BS., MS,
101 MD, PhD, DVM, MPH), and contribute within a variety of roles (e.g., technician, staff
102 scientist, postdoctoral fellow, principal investigator, team lead, chief, director). This is
103 one of the strengths of working at CDC. There is a wealth and unique concentration of
104 infectious disease and public health experts with an array of expertise in different
105 disciplines, and the quality of the interactions between those colleagues is a
106 foundational strength.
107
108 Many scientists at CDC began their journey as in-house trainees, often affiliated with
109 one of many fellowship opportunities. Traditional postdoctoral opportunities are
110 available at CDC, as well as fellowships sponsored by outside programs such as the
111 Oak Ridge Institute for Science and Education (ORISE) and American Society for
112 Microbiology (ASM) (4-7). In addition, the Epidemic Intelligence Service (EIS) and
113 Laboratory Leadership Service (LLS) programs are unique to CDC, training health
114 professionals and scientists to become future public health laboratory leaders. The EIS

program trains fellows as “disease detectives,” with a focus on investigating public health problems and disease outbreaks in the field (8), while the LLS program trains fellows in the science of biosafety, laboratory quality management, and laboratory leadership (9). Many successful fellows at CDC go on to permanent positions and eventually transition into leadership roles. However, a postdoctoral fellowship is not the only route to a research position at CDC. Scientists at various career stages have been brought on board to fulfill a specific need, often through experience they garnered elsewhere. Expertise in a specific viral pathogen, a groundbreaking technology, or a particular aspect of infectious disease biology are among the common reasons scientists join CDC.

Both Cara and I came to CDC as early-career scientists, having completed graduate and postdoctoral programs at top-level academic research institutions. We each transitioned to CDC following postdoctoral training, Cara having made the transition nearly two decades ago and myself two years ago. We both are Team Leads in the Polio and Picornavirus Laboratory Branch (PPLB), within the Division of Viral Diseases, which resides in the National Center for Immunization and Respiratory Diseases. Cara leads PPLB’s Molecular Epidemiology and Surveillance team, while I lead the Vaccine Development team. In addition to our two teams, there are three additional teams within our Branch: Population Immunity, Polio Molecular Diagnostic Development, and the (non-polio) Picornavirus team. Each team tackles a unique aspect of poliovirus or picornavirus biology and surveillance, together supporting the control of picornavirus disease and global polio eradication.

Cara earned her PhD from the University of Utah, studying various aspects of poliovirus replication. Her postdoctoral training at the University of Washington in Seattle included research on feline leukemia virus evolution and pathogenesis, as well as HIV-1 integrase evolution. The opportunity to collaborate with colleagues in Kenya on HIV-1 research strengthened Cara's desire to continue pursuing infectious disease research in a global public health setting. She joined CDC's Molecular Virology Section, a precursor to PPLB, focusing on poliovirus molecular epidemiology and vaccine research. The team was an outstanding fit with Cara's desire to study the underlying causes of viral disease, with hopes of developing tools for prevention of infection and illness. Cara initially came on board as a Research Microbiologist, conducting independent work in polio vaccine research and molecular epidemiology, and guiding one technician. She transitioned to a formal Team Lead position 10 years ago. The scope of her work has expanded and shifted with changing demands and reorganization. Her current team is responsible for polio diagnostics, molecular epidemiology (including viral genome profiling via Sanger and next-generation sequencing), bioinformatics, and environmental surveillance. As her participation in the Global Polio Laboratory Network expanded with increased travel and more senior consultations, additional responsibilities evolved into stints as the Acting Branch Chief and the position of Deputy Branch Chief.

I earned my PhD from the University of North Carolina at Chapel Hill, followed by postdoctoral training at Vanderbilt University. In both training settings, my research focused on understanding the pathogenesis of viruses targeting the central nervous

system, including Venezuelan encephalitis virus and mammalian reovirus. Both projects were highly collaborative with other research groups, an environment I very much enjoyed and thrived in. When it came time for my job search, I found myself drawn to research positions in highly collaborative environments that would allow a bridging between pathogenesis research and public health, in which the immediate application of work occurring at the bench was more tangible. The opportunity to join PPLB as a Team Lead and help guide the effort to design a new generation of polio vaccines to support the eradication effort stood out as a challenging role within the type of dynamic research environment I was seeking. It also afforded me the opportunity to continue to investigate neurotropic viruses and the diseases they cause, with a new emphasis on the public health impact.

The Team Lead position at CDC is perhaps most akin to an academic PI. As such, skills that were developed and honed as a postdoc serve well in the transition from fellow to Team Lead, much like they would in the transition to academic PI. This includes designing and conducting experiments, thinking broadly about science, managing multiple research projects, guiding technicians and junior scientists, staying abreast of the literature, and effective scientific writing, speaking, and presentation skills. While completion of a postdoctoral fellowship is not necessary to join CDC as a scientist, the training and skills garnered during a postdoc are essential to the Team Lead or similar position. That is not to say that the same learning curve when transitioning from postdoctoral fellow to PI does not also exist here. As seems to be the case in other science career paths as well, managing a team, learning to balance budgets and

equipment needs, forecasting goals, and contributing to agency programs are skills that develop fully once on the job.

Working at CDC as a research virologist

What does an average week for an infectious disease Team Lead at CDC look like? In many ways, it seems similar to that of an academic PI. We work with our team members to design experiments and guide project progress. We manage and interpret new data. We perform administrative tasks and sometimes directly supervise experiments. We address requirements for improving laboratory safety and scientific quality. We prepare reports and presentations summarizing new findings for colleagues and outside partners. We review manuscripts for journals and keep up with the literature. Publishing is encouraged and expected at CDC, so time is dedicated to crafting storyboards and writing manuscripts. There is also a wealth of seminars at CDC, both to attend and to present new research.

The unique nature of fulfilling these tasks and responsibilities as a Team Lead at CDC comes through in the dynamic, crosscutting, highly collaborative environment where they take place. Nothing is done within a bubble. The research conducted by each team within PPLB directly informs that of the other four teams. New case information provided by CDC polio response epidemiologists combines with PPLB molecular surveillance to track and trace outbreaks. Weekly or monthly project updates with outside partners at the World Health Organization (WHO) and the Bill and Melinda Gates Foundation (BMGF) bring together global partners striving to reach the polio eradication goal. Team

Leads and senior virologists often play key roles in global or domestic laboratory networks, contributing to surveillance strategies, designing and providing molecular testing reagents, and serving as WHO temporary consultants to train international laboratory partners. One of the highlights of Cara's CDC experience has been accompanying vaccinators house-to-house in Delhi, India, just a few months prior to the last wild poliovirus case in India. The international reach of CDC's mission in fighting infectious disease is certainly a unique and rewarding element. The enormous concentration of infectious disease expertise at CDC is also quite unique. For example, in NCIRD we are joined by colleagues who study measles, mumps, rubella, influenza, rotavirus, coronaviruses, herpesviruses, and other respiratory and gastroenteritis pathogens. In neighboring Centers, colleagues investigate other viruses such as HIV, viral hepatitis, Ebola, and arboviruses including Zika, Chikungunya, and Dengue, just to name a few. We have focused on virology at CDC for this article, but of course are joined by an invaluable network of colleagues who study diverse bacterial pathogens as well. This rich concentration of infectious disease specialists, particularly the unique combination of laboratory and epidemiology expertise, fosters collaborative projects and mentoring between colleagues. Being immersed in a work culture that seeks to better understand and control so many dynamic aspects of global infectious disease makes working at CDC as a research virologist extremely rewarding.

Is CDC a "good fit?"

It is true that one of the most attractive aspects of academic research is the freedom to choose the depth and scope of your research focus, as well as the pursuit of whatever

direction the projects may lead. If that element is a primary driver for a love of research science, then it will be important to consider this particular difference between academic paths versus CDC. However, one of the most unique aspects of CDC is the ability to bridge research and public health service. This is reflected in the scope of research projects, the access to both domestic and international clinical specimens, and the commitment to global monitoring and control of infectious disease. Exposure to active outbreak response and the opportunity to get engaged is also unique to the CDC experience. As a scientist at CDC, there are multiple opportunities to actively participate in an ongoing surge response to an outbreak situation. These include volunteering for temporary detail in the field or with other teams on campus when specific expertise is needed, as well as opportunities to flex problem-solving and communication skills by participating in CDC's Emergency Operations Center (EOC).

While access to cutting-edge equipment and well-appointed facilities is a perk at CDC, a false notion of living a scientific life that is free from funding stresses and grant-writing responsibilities may initially attract some to consider a research position in a government agency. However, while grant-writing duties and pressure to secure a full repertoire of funding may be less at the forefront, unlimited funding from the Federal budget is also not a reality. As a government-funded agency, CDC adheres to good stewardship of public funding by pursuing and prioritizing research that directly supports our public health mission. Top-priority infectious disease research includes improving the detection, tracking, and response to outbreaks, as well as supporting the prevention or control of infectious diseases that pose risk domestically or globally. This mission-

driven mindset can at times limit the amount of freedom to pursue every avenue of basic research that might arise along the way. That being said, there is time and opportunity to do basic research at CDC, especially that which seeks to better understand the nature or threat of infectious disease. In fact, in-house innovation grants and fostering of collaborations with outside partners often present opportunities to flex grant-writing skills and seek supplementary funding.

The mentoring of graduate students is also a notable difference between the key roles of an academic PI and that of Team Leads. While CDC does not have traditional graduate programs, opportunities to train and mentor young scientists do exist. They include mentoring postdoctoral fellows, hosting summer and work-study students, and training domestic and international visiting scientists. Team Leads also encourage research staff at all stages to master new techniques and technology and to develop critical skills like scientific writing and presenting research at conferences or in-house seminars. In addition, some CDC virologists serve on academic thesis committees or hold joint appointments at nearby universities. However, if intense participation in graduate school training and mentoring programs is a central career interest, this difference may require further consideration.

The topic of work-life balance has gained increasing attention across all scientific fields (10-11), and it is worth noting that a healthy respect for balancing career and personal endeavors exists at CDC. This is of course not to say that workload demands don't naturally wax and wane, particularly since many infectious disease cycles are seasonal

and outbreaks in general tend to be unpredictable. However, CDC does offer benefits and programs that encourage a healthy work and lifestyle mindset. This includes features such as annual leave, flexible work schedules, access to a number of health and retirement benefit options, and well-appointed onsite daycare and gym facilities. The agency also promotes the benefits of a healthy active lifestyle and offers several employee support programs that help identify new strategies and practices to achieve success in work-life effectiveness. Additionally, while productivity and innovation is of course expected and lauded at CDC, many do see advantages in a chosen path that offers career stability not intimately tied to procurement of NIH grants or the market value of commercial products.

Closing words

If conducting infectious disease research with a public health impact in a highly collaborative, mission- and team-driven environment is appealing, then a career at CDC is definitely worth serious consideration. There are formal programs for applying to ORISE, ASM, EIS, and other fellowship programs. Many CDC regular fellowship positions are filled through networking, much like traditional academic postdoc positions. Non-fellowship positions for U.S. citizens are posted to the central U.S. government job website (www.usajobs.gov). Setting up automatic searches based on keywords (e.g., a specific pathogen, technology, skill), agency of interest (e.g., CDC), or desired position are helpful in mining for new job postings. As you progress through your graduate and postdoctoral programs, skills that are critical to hone are similar to those of the academic PI route. This includes thinking broadly about projects and

299 developing the ability to see the forest through the trees in terms of goals and the
300 impact of your research. Effective scientific presenting and speaking skills are key. Seek
301 opportunities to talk about your science in formal and informal settings with diverse
302 audiences. Build mentoring relationships with graduate students or junior postdocs, and
303 find opportunities to build new bridges between your work and others' projects.
304 Mentoring and managing multiple projects often translates into developing supervisory
305 and time management skills. While not required for a career at CDC, any opportunity to
306 gain knowledge in epidemiology is certainly valuable, whether it is found in the form of
307 an introductory graduate-level class or collaboration on an aspect of an ongoing
308 research project. As is true across the spectrum of scientific career paths, networking is
309 critically important. Speak to those you know in positions you are interested in,
310 approach them with questions, and see if opportunities exist for short internships or in-
311 person visits to get a firsthand feel. You may not know someone who is at CDC
312 currently, but you likely have colleagues who do. A position as a research scientist at
313 CDC can be immensely rewarding, and many of us are eager to share our experiences
314 with early-career scientists who have the desire to follow a similar path and conduct
315 infectious disease research in a dynamic, public health setting.
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