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Training the Next Generation of Geriatric-Focused Clinical Neuroscientists

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ABSTRACT

It remains challenging to integrate clinical neuroscience into clinical practice. Hindrances at the training level (e.g., lack of qualified faculty and curriculum) contribute to this impasse. To help address this, we present a model of training in clinical neuroscience. We expand on a growing literature on incorporating neuroscience into psychiatry training by emphasizing two points. That is, 1) we propose a training model designed for the geriatric-minded clinician; and 2) that extends across several phases of education and career development. Considering the relevance of dementia to our population of interest, and the potential impact expertise in clinical neuroscience can have in elders with cognitive impairment, we provide relevant curriculum examples at various training stages. Clinical research, both as a practitioner and consumer, figures prominently into our training model. We discuss two mentoring programs, T32 fellowships and Research Career Institute in the Mental Health of Aging, as ways to engage geriatric psychiatrists early in their training and transition them successfully to post-residency clinical investigator positions. Although there is increasing opportunity for geriatric psychiatrists and other clinicians to become leaders in the field of neuroscience, this remains a work in progress; ours and others' training programs continue to evolve based on input from trainers and trainees alike, as well as from the increasing literature on this important topic. (Am J Geriatr Psychiatry 2019; 27:720−727)

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INTRODUCTION

Our knowledge of brain and behavior relationships has gradually accrued over the last several decades. Over 10 years ago, "clinical neuroscience" was suggested as a blended discipline from which practitioners could apply psychiatric and neurologic insights to the care of patients with neuropsychiatric disorders.[1] The understanding of clinical neuroscience was accelerated, at least in part, from advancements in genetics and functional neuroimaging. Moreover, with the advent of innovative research frameworks and initiatives (e.g., the Research Domain Criteria [RDoC] Project), our knowledge of transdiagnostic neurobehavioral systems has clearly progressed. Yet, as Ross et al.[2] note in a recent editorial, it remains challenging to integrate clinical neuroscience into clinical practice. Clinical neuroscience has not created a paradigm shift in the way most clinicians (including geriatric-focused practitioners) approach patient care.[2] What's more, despite 50 years of sounding the call to do so, neuroscience, neuropsychiatry, and neurology generally remain poorly integrated into the training of (geriatric) psychiatry.[3]

The availability of training has limited the degree to which this discipline can improve clinical care. Elaborated in the following sections, there is a discrepancy between the perceived need for quality neuroscience training and the availability of such training in medical schools and residency programs. The lack of qualified faculty and available curriculum contributes to this discrepancy,[4] and propagates a diminished pipeline of geriatric psychiatrists with expertise in clinical neuroscience.[5] Such expertise is critical to adequately serve our population of interest. For example, a patient with a recent clinical diagnosis of mild cognitive impairment will have questions related to etiology and treatment,[6] and therefore benefit from a clear understanding of neuroscientific methods to enhance diagnosis and potentially change treatment recommendations[7] (e.g., amyloid-beta positron emission tomography (PET), fludeoxyglucose PET scan, dopamine transporter scan, lumbar puncture, genetic testing).

We propose a training model for clinical neuroscience designed for the geriatric-minded clinician that extends across several phases of interdisciplinary team education and career development. Considering the increasing numbers of our patients with cognitive disorders, and the potential impact expertise in clinical neuroscience can have in this population, we use mild cognitive impairment/dementia as a teaching example across various stages of training. We begin our model with examples of curricula that illustrate the integration of neuroscience into medical school and residency training. We then describe ways to promote the development of clinical investigators who are interested in incorporating clinical neuroscience research into their career. Here, we discuss two mentoring programs, T32 fellowships and Research Career Institute in the Mental Health of Aging (CIMA), as ways to engage candidates early in their training and transition them successfully to post-residency clinical investigator positions. Although many of the examples described in the following text involve training of medical professionals, several core elements of the training model are applicable to other disciplines (e.g., psychology, nursing).

Clinical Neuroscience in Medical School: The University of Connecticut School of Medicine M Delta Curriculum

Education in clinical neuroscience should begin at the earliest stages of training.[8] The M Delta curriculum at the University of Connecticut (UConn) School of Medicine was implemented in 2016 and emphasizes a team-based learning approach to medical education. With team-based learning, students are organized into small collaborative groups in which individual team members can articulate their thinking and assess their own reasoning in consideration of the potentially different decisions that other students and teams may make. Faculty facilitators encourage students to practice problem solving and the application of knowledge in clinical case-based exercises, reflective of contemporary methods in medicine. Each group strives to reach a consensus in answering the questions posed. The expectation is that applying knowledge in an active learning model will give rise to longer retention and deeper understanding of information than traditional lecture-based approaches of passive learning. Team-based learning approaches have been used in medical schools with success demonstrated by measurable knowledge gains and subjective endorsements from students and faculty.[9]

Interdisciplinary faculty leads the patient-centered and case-based UConn M Delta curriculum. For example, content experts in the core course "Dementia" include geriatric psychiatrists, neurologists, basic neuroscientists, and neuropsychologists. The content experts represent a partnership between communities of basic scientists and clinicians, who then encourage 1-hour discussions of brain-behavior relationships across various diseases. Prior to meeting with content experts in the classroom, students are expected to study related educational materials (e.g., readings, videos). In class, discussion then revolves around question and answers pertaining to case descriptions. Having content experts in the same room together can easily expand the scope of the discussion and provide an in-depth learning experience in real-time.

The goals of the Dementia course are to provide medical students with an introduction to the identification, evaluation, and treatment of dementia syndromes. Case descriptions of common cognitive disorders in late life are presented (i.e., Alzheimer disease, vascular dementia, Lewy bodies disease, frontotemporal dementia, geriatric depression; Table 1 provides a case example). Suspected underlying pathologies are discussed. Examples of evaluation procedures explored in the case descriptions include neuropsychological testing (e.g., how is cognitive testing used to differentiate between normal aging and disease states) and neuroimaging (e.g., explanation of common age-related changes on structural magnetic resonance imaging; PET and dopamine transporter scan used to differentiate between different dementia syndromes). Discussions on treatment center on the cholinergic and glutamatergic systems. Through these case description discussions of the M Delta curriculum, students become familiar with: 1) the strengths and weaknesses of current clinical practices; and 2) an understanding of ways in which clinical neuroscience can help address practice limitations. Since the two years the course has been in existence, 72% of medical students have either agreed or strongly agreed that the course was educationally effective.

Research opportunities aim to enhance the M Delta curriculum. For example, the Geriatric Mood and Cognitive Disorders Research Group (led by author DCS) provides medical students with the opportunity to gain further experience in age-related clinical neuroscience, either as a voluntary Summer project or a 2-year curriculum required capstone project that spans the third and fourth years of medical school. With faculty guidance, medical students develop independent secondary research projects using collected clinical, neurocognitive, and structural and functional neuroimaging data from our geriatric research studies. Although the experience is tailored to meet the sophistication of the student, general training goals of our research offering are to increase familiarity with: 1) age-related changes in neurobehavioral systems and neural networks (e.g., cognitive

TABLE 1. UConn M Delta Curriculum Dementia Course Case Example

Case Description:

A 78-year-old man with a graduate degree who presented to neurology with a six-month history of slow, shuffling gait, and complaints over balance. History was notable for hepatitis C, hypertension, and a longstanding history of depression. In the month or two before his neurology appointment, he began to complain of visual hallucinations. On interview, the patient's wife reported noticing a change in his memory three years ago that has gradually worsened. Neurologic exam revealed increased rigidity in the upper extremities and reduced facial expression. Cognitive screening was a 23/30 on the Montreal Cognitive Assessment. Points lost in executive function, cube copy, and word recall. Depression screening was positive 8/15. Recent magnetic resonance imaging of the brain revealed mild volume loss and periventricular and deep white matter gliosis.

Question(s): List three possible explanations for his cognitive decline and motor symptoms? What is his most likely diagnosis?

Potential Content Expert Discussion Points:

Psychiatry	Neurology	Neuroscience	Neuropsychology
- Difference/overlap in depression and dementia syndromes - Treatment of mood disturbance	- Explanation of neurologic exam - Other imaging or diagnostic tests that could be ordered - Treatment of movement/cognitive disorder	- Description of potential underlying pathology	- Use and interpretation of cognitive screening tests - Typical cognitive profile associated with disorder

control system, executive control network); 2) assessments that enhance pre-clinical dementia classifications (e.g., amyloid PET, cerebrospinal fluid analysis, magnetic resonance imaging, subtle cognitive decline); and 3) nonpharmacological treatments for cognitive and mood disorders. During the Summer, students attend weekly research meetings and work side-by-side with the interdisciplinary members of the Research Group (e.g., geriatric psychiatrists, neuroscientists, biostatisticians, neuropsychologists).

Clinical Neuroscience Training in Residency: The UConn Psychiatry Residency Program

There is a need to integrate more neuroscience training into psychiatry residency programs. In a recent survey[10] completed through the American Psychiatric Association, 49% of practicing psychiatrists and 39% of psychiatry trainees described their neuroscience training during residency as "less than adequate" or "inadequate." Likewise, 27% of practicing psychiatrists and 38% of psychiatry trainees reported their fund of neuroscience knowledge as "less than adequate" or "inadequate." These numbers are in contrast to the opinions of stakeholders (e.g., residents, resident training directors, department chairs) who overwhelmingly endorse the importance of neuroscience training in elucidating the pathophysiology of psychiatric illness and providing better treatment targets.[10,11]

There are several excellent published recommendations for enhancing clinical neuroscience training during residency.[2,4,8,12−14] We summarize some of the major suggestions here. First, neuroscience training should expand on the foundation developed in medical school.[8] For example, whereas the UConn M Delta curriculum emphasizes the case example as a method to illustrate brain-symptom relationships in one disease at a time, during residency there should be a transition to understanding how neurobehavioral systems contribute to multiple diseases.[15] Second, similar to lesion localization exercises in neurology training, psychiatry residents should be encouraged to conceptualize symptom presentations in terms of neurobehavioral system dysfunction.[14] Finally, formal lectures should highlight a neurobehavioral system (e.g., executive control network, reward/salience system) rather than *Diagnostic and Statistical Manual of Mental Disorders*-based diagnostic boundaries,[14,15] consistent with current conceptualizations in the field.[16−18] Interested readers are encouraged to consult: 1) Etkin and Cuthbert[15] for an excellent example of a neuroscience course centered on transdiagnostic neurobehavioral systems; and 2) Benjamin et al.[4] for neuroscience-based milestones in psychiatry residency. In the following text, we describe the UConn Psychiatry Residency program as an example of a training program that continues to evolve to meet the neuroscience educational needs of psychiatrists.

The UConn Psychiatry Residency Program fosters clinical training in neurology and specialty services, including geriatric psychiatry and neuropsychology. Throughout all years of training, residents participate in seminars related to neuroscience, geriatric mental health, and neuropsychological assessment. Clinical neuroscience lectures are emphasized in an 8-month third year course. Similar to the M Delta student curriculum, interdisciplinary faculty share teaching responsibility for this course titled "Advanced Neuropsychopharmacology." Although psychiatrists are responsible for the majority of the 31 lectures in this course, a neuroscientist leads two lectures devoted to the application of neuroimaging techniques to the study of psychiatric disorders, and a clinical neuropsychologist teaches four lectures on brain and behavior relationships in neuropsychiatric disorders. Lectures strive to meet the example of Etkin and Cuthbert[15] by taking a transdiagnostic neurobehavioral systems approach. For example, the learning goals of one lecture are to 1) become familiar with the functional neuroanatomy of the executive control network; and 2) understand how dysfunction to this system contributes to behavior, cognition, and mood in various age-related illnesses (e.g., Alzheimer disease, Frontotemporal Dementia, Late-Life Depression).

Residency obviously involves more than simple didactics. Ross and Rohrbaugh[19] keenly observe that if neuroscience educational concepts are not incorporated into in clinical practice, this reinforces the notion that neuroscience is not critical to clinical care. Therefore, although barriers to implementing clinical neuroscience into the classroom include the lack of faculty and developed curriculum,[4] one challenge to sustaining the curriculum is the continuous reinforcement of principles learned in seminar. To address this, residents are encouraged to continue to conceptualize cases in terms of both clinical symptoms and underlying neural networks (see the "Insel Method" described by Ross and Rohrbaugh[19]). Interdisciplinary clinics provide a practical experience in which neuropsychiatry patients are discussed from several perspectives. For example, geriatric psychiatry trainees at UConn are embedded within the Center on Aging alongside geriatricians, neurologists, and neuropsychologists.

Fellowship Neuroscience Training: The University of Pittsburgh T32 in Clinical and Translational Research Training in Geriatric Mental Health

Clinical fellowship is an excellent opportunity to gain expert-level training in clinical neuroscience, but it is also vital to promote future investigators by ensuring there are opportunities in research career development. Since 1997, the NIH has supported a T32 research training program at the University of Pittsburgh for Clinical and Translational Research Training in Geriatric Mental Health (T32 MH019986). The program provides post-residency physicians and Ph.Ds. with an additional 2–3 years of mentorship and training to be a successful investigator in geriatric mental health research. It focuses on a critical transition in the progression to independent investigator. The training program embraces the breadth of the research approaches used in geriatric mental health research, spanning molecular science to services research. Training in clinical neuroscience has become an increasing component of the program, with the interdisciplinary training faculty actively promoting the development of a cohort of early career clinical neuroscientists.

The most important component of the training program is an apprenticeship with a productive mentor and mentoring team. The T32 program addresses the need to increase trainees' *knowledge* of research career development strategies and skills; provide individualized *guidance* on each fellow's research designs and career strategies; and promote the development of effective interdisciplinary collaborative *relationships*. This latter point is key to translating neuroscience findings into clinical practice as well as maintaining the "pipeline" neuroscience focus of clinician-scientists. Individual goals obviously vary by research focus/discipline, and course work and didactic offerings are assigned to each trainee based on an assessment of their individual needs. The program has served a diverse pool of M.D./Ph.Ds. Of the 26 graduates of the program, there are 12 psychiatrists, two neuroscientists, one internist, two geropsychologists, two neuropsychologists, two geriatric mental health nurses, and one each from the fields of social psychology, behavioral gerontology, pharmacy, social work, and biomedical engineering.

The interdisciplinary training team of investigators has complementary skills spanning the spectrum of translational, intervention, and services research. The main themes in research training reflect the breadth of multidisciplinary geriatric mental health research and respond to the needs of the field for researchers in prevention, clinical therapeutics in late-life mood, anxiety and sleep disorders, cognitive, clinical and affective neuroscience, neuroimaging, and geriatric mental health services research. The fellows develop and submit competitive NIH research career development (K23, K01) or other grant proposals (usually to foundations) that will help them transition to the status of an independent investigator. There are challenges with the T32 program. The percentage of T32 positions held by physicians has declined in recent years to coincide with a reduction in the number of physicians endorsing research as their major professional activity. Financial factors may contribute here; student loan debt for U.S. medical schools has risen, dependence on grant funding within academics may lead to financial uncertainty.[20] Although shortening the required years of training for geriatric psychiatrists may alleviate some of these burdens,[5] additional supports are needed to promote independent investigators in clinical neuroscience. One such program, the CIMA, is discussed in the following section.

Early Career Mentoring in Neuroscience: CIMA

Training in clinical neuroscience does not have to end on completion of fellowship. CIMA is a national mentoring program funded through an NIMH-funded R25. CIMA is designed to promote the research career of post-residency and post-doctoral fellows and junior faculty interested in: 1) the etiology, neurobiology, and/or neurodevelopmental trajectories of mood, cognitive, and other behavioral pathology occurring in middle and late life; 2) the development and testing of neurobiologically informed novel treatments and prevention strategies for aging-related mental health needs; and 3) the delivery of such neurobiologically inspired mental health services to the aging community. The specific aims of the CIMA are to: 1) help mentees clarify their own career focus and maximize their ability to pursue a research career in settings best matching their research interests and strengths; 2) impart to mentees the attitudes and knowledge needed to maximize their research productivity, including their publication record, and guide them in obtaining and retaining the requisite skills; and 3) increase mentees' ability to compete for early career investigator grants and awards.

CIMA's primary training vehicles include an annual, 5-day research career development immersion seminar that provides ongoing mentoring using a small-group format focused on both content (research focus and skill development) and career planning. CIMA also uses a web-based, career development infrastructure to support ongoing, offsite mentoring, professional networking, and information exchange. For example, as it can be challenging for participants to carve out research time depending on their effort allocation, several seminars are given on tips to carve out writing time and work/life balance. The mentoring team comprises interdisciplinary mentors, many of whom have expertise in a range of neuroscience techniques including neuroimaging, cognitive and affective neuroscience, genetics of psychiatric illness, and neurobiologically informed interventions, including neuromodulation, cognitive remediation, and psychotherapies. The mentors expose the mentees to research approaches critical for each individual mentee's development. Moreover, the mentors help keep open the pipeline of clinician-scientists through networking and fostering collaborations. The content and spirit of CIMA was motivated, but not limited to, the following cross-cutting neurobiologically relevant themes in NIMH's 2015 Strategic Plan:

- The RDoC Project[21,22] reflects the field's current consensus and recognizes the readiness of neurobiology to guide research on mechanisms and treatment of mental disorders. Its principal assumptions are that mental illnesses are disorders of brain circuits and that dysfunction of these circuits can be identified by tools of clinical neuroscience.[23] The RDoC Project promotes a consensus development process, which includes an agreement of what constitutes valid knowledge at this point and where to start further research. The RDoC approach and the RDoC consensus findings are part of the core curriculum of the CIMA and a continuous point of reference for CIMA's mentors and the projects of its trainees.
- CIMA includes both formal instruction and mentoring guided by the NIMH's experimental therapeutics initiatives. This model focuses on identifying a target that, if engaged, will alter the trajectory of cognitive and affective symptoms in mental health conditions.[24,25] The content-focused individual and small-group mentoring follow the NIMH's premise that "modification of the target will result in improvement of symptoms, behavior, or functional outcomes."
- The BRAIN Initiative focuses on developing new technology and approaches to understanding complex neural circuitry.[26,27] Several of the CIMA faculty focus on innovative approaches (connectome analyses, machine learning techniques, and optogenetics) to understand network functions in both normal brain functioning and psychopathology. CIMA provides a brief overview of such innovative approaches to understanding network functions and, when relevant, guide trainees in finding expertise and mentoring in these approaches at their home institutions or elsewhere.

In summary, CIMA relies on a national network of mentors to prepare academically minded post-doctoral fellows and junior faculty for research careers focused on the aging of mental health. A primary emphasis is on preparing individuals to pursue questions focused on the clinical neuroscience of aging and mental health to guide the development and dissemination of more effective interventions for older adults suffering from mental illness.

CONCLUSION

Early training that progresses over several career phases and is supplemented by formal mentoring programs may 1) lead to changes in the way neuroscience is incorporated into clinical practice; and 2) help ameliorate the diminished pipeline of clinical-scientists interested in pursuing neuroscience careers.

Using cognitive disorders as an example, we have illustrated how age-related neuroscience can be integrated into the curriculums of medical students and psychiatry residents. These early didactic experiences in geriatric psychiatry may be enhanced through hands-on learning in clinical research, a mandatory component of medical education at the UConn. Clinical neuroscience research at UConn introduces medical students to neurobehavioral systems and related neural networks and illustrates the value of highly promising (but not yet clinically approved) pre-clinical dementia identification methods. Early data from UConn suggests the majority of medical students find the cognitive disorders course effective in providing a foundation in clinical neuroscience. Subsequent to residency, the T32 and CIMA programs are presented as ways to engage clinician-scientist candidates early in their training and help transition them successfully to post-residency clinical investigator positions.

These training experiences share an interdisciplinary team approach to education that emphasizes both clinical and research based experiences. Furthermore, the examples noted earlier benefit from strong support of their respective institutions and faculty. This is not to say these training experiences cannot be improved on. In fact, as noted by Goldenberg and Krystal,[28] clinical neuroscientists can be recruited as undergraduates well before medical school. To engage undergraduates in neuroscience and all other research areas, UConn has recently implemented a program designed to pair undergraduates with a Summer mentor in basic or clinical research in the School of Medicine. Although still in its infancy, we have attracted undergraduate applicants with diverse backgrounds (e.g., biomedical engineering, basic neuroscience, psychology) who seek to learn more about clinical neuroscience. Although future objective data are needed to judge the success of this and similar programs, they may help encourage the next generation of physician-scientists. Second, for even experienced lecturers, some degree of teacher training is recommended when using the team-based learning format.[19] Third, at the resident level, joint didactics and journal clubs for both neurology and psychiatry residents as well as neuroscience graduate students may be useful in establishing early interdisciplinary collaborations and encouraging novel research paths. We look forward to implementing these suggestions into our own programs and reporting on their efficacy.

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