Training and Career Development in Clinical and Translational Science: An Opportunity for Rehabilitation Scientists

Thomas H. Kelly and Carl G. Mattacola

**Context:** The National Institutes of Health’s Clinical and Translational Science Award initiative is designed to establish and promote academic centers of clinical and translational science (CTS) that are empowered to train and advance multi- and interdisciplinary investigators and research teams to apply new scientific knowledge and techniques to enhance patient care. Among the key components of a full-service center for CTS is an educational platform to support research training in CTS. Educational objectives and resources available to support the career development of the clinical and translational scientists, including clinical research education, mentored research training, and career development support, are described. **Objective:** The purpose of the article is to provide an overview of the CTS educational model so that rehabilitation specialists can become more aware of potential resources that are available and become more involved in the delivery and initiation of the CTS model in their own workplace. Rehabilitation clinicians and scientists are well positioned to play important leadership roles in advancing the academic mission of CTS. Rigorous academic training in rehabilitation science serves as an effective foundation for supporting the translation of basic scientific discovery into improved health care. Rehabilitation professionals are immersed in patient care, familiar with interdisciplinary health care delivery, and skilled at working with multiple health care professionals. **Conclusion:** The NIH Clinical and Translational Science Award initiative is an excellent opportunity to advance the academic development of rehabilitation scientists.

**Keywords:** Clinical and Translational Science Award (CTSA), supplemental research education and training for professionals, multidisciplinary research, team science

Professional schools that prepare future rehabilitation clinicians and scientists continue to refine curriculums to meet the ever-expanding knowledge base and expectations of the profession. As many professions have embarked on educational initiatives culminating with clinical doctorates, exposure to clinical or basic-science research opportunities is often not readily available. Programs that provide research
training often focus on areas of institutional and faculty expertise, mostly directed toward clinical research. Specialists trained in clinical research provide an important resource for the current clinical and translation model. Development and training of basic scientists is expanding, but the application and delivery to patients is often lacking. Rehabilitation specialists provide a unique cohort. They understand clinical research, are involved in the application of therapy, and have access to patients so that the most basic of hypotheses can be tested.

Unless you are an avid reader of *Nature* or affiliated with a major research university you may not be aware of the educational initiative of the National Institutes of Health (NIH), specifically related to clinical and translational science (CTS).1–3 The purpose of this article is to provide an overview of the CTS educational model so that rehabilitation specialists can become more aware of available potential resources and more involved in the delivery and initiation of the clinical and transitional model in their own workplaces. Note that training opportunities for rehabilitation clinicians and scientists, as well as other professionals with career interests that interface with the rehabilitation sciences, are emerging as important components of CTS programs including the Clinical and Translational Science Institute at the University of Pittsburgh, the Harvard Clinical and Translational Science Center, Northwestern University Clinical and Translational Sciences Institute, and the University of Wisconsin Institute for Clinical and Translational Research.

**CTS’s Educational Mission**

As discussed in another article in this special issue,4 the NIH Clinical and Translational Science Award initiative is designed to establish and promote academic centers of CTS that are empowered to train and advance multi- and interdisciplinary investigators and research teams to apply new scientific knowledge and techniques to enhance patient care. There are 55 CTS awards to medical research institutions, and on completion of the program it will total 60. One of the key components of a full-service center for CTS is an educational platform to support research training in CTS. The platform should provide integrated and flexible research education, training, and career-development resources and support for those interested in careers in multidisciplinary team-based CTS (Figure 1). Innovative methods and approaches are needed to provide professionals and other clinical research personnel with the competencies needed to advance CTS.

**Clinical Research Education**

Clinical research is by necessity a multidisciplinary pursuit. CTS research educational programs must recognize the importance of integrating with and supporting scholars with diverse academic backgrounds, such as medicine, pediatrics, surgery, dentistry, nursing, pharmacology, and rehabilitation science, as well as other key clinical research personnel relevant to CTS. Furthermore, multidisciplinary teamwork is a key skill set for clinical and translational scientists, and an academically diverse scholarly community is an important resource for training the skills required of multidisciplinary research teams.

A key component of the clinical and translational educational mission is the development of graduate-degree-granting and postgraduate programs in CTS
Figure 1 — Integrated research education, training, and career-development resources for multidisciplinary team-based clinical and translational scientists.
These programs should be designed to provide the competencies (e.g., communication skills, professionalism, critical thinking and synthesis of knowledge, leadership) and knowledge base (e.g., clinical research design, epidemiology, biostatistics, pharmacology, biomedical informatics, responsible conduct of research, behavioral science, health economics, federal policies and regulations that address research with human subjects, scientific writing for publication, team leadership and preparation of competitive grant applications) needed by clinical and translational researchers, irrespective of their primary interest, degree, or discipline. An example of the competencies for the CTSA certificate program at our institution is in the Appendix. It is important to note that for each of the major components (research integrity, CTS methods and technologies, scientific knowledge, measurement and statistics, and collaboration and team building), a consistent set of competencies is outlined for completion.

In addition to developing degree programs, institutions have elected to create certificate programs and intensive course programs to introduce clinicians to the clinical translational process and advanced educational opportunities.\textsuperscript{5,6} For example, the University of Illinois at Chicago has incorporated a 3-day intensive program in clinical and translational research methods for clinicians interested in incorporating research into their clinical practice. The course discusses research methods, examines the best approaches to clinical research, outlines the steps required for conducting clinical research, and provides instruction on critiquing peer-reviewed articles.\textsuperscript{5} The purpose of many certification programs is to provide a series of courses that provides entry-level competency training in CTS. Such a program is the entry point for scholars interested in careers in CTS.\textsuperscript{6} Often the course work in certificate programs can be applied to a degree program, thus providing a seamless entry to advanced education for busy clinicians.\textsuperscript{6} Mechanisms such as intensive programs and certificate programs provide flexible and accessible opportunities to advance the integration of translational research.

### Research Training

The mentor–trainee relationship is arguably the single most important predictor of success for scholars in the early stages of their research career development.\textsuperscript{7} Traditionally, mentors provide critical scientific and research knowledge that cannot be transmitted in the classroom setting. In addition, mentoring is important because of the many “survival skills”—such as grant preparation, personnel and financial management, networking skills, and balancing personal and professional obligations—needed for career success. It is a vitally important component to increasing the number of clinical and translational researchers and facilitating improved productivity.\textsuperscript{8} Finally, with the multiple pressures imposed by the research environment, a mentor who has established a successful research career is the pillar on which a more junior researcher can rely in seeking his or her own formula for success.

A second key component of the clinical and translational educational mission is mentored research training. The development of resources and procedures for (1) matching scholars and mentors, (2) maintaining a robust community of academically vigorous mentors through mentor training and career-development support of clinical and translational scientists engaged in sponsored clinical research who can serve as effective mentors, and (3) assessment, evaluation, and replacement is fundamental to supporting a rigorous program of mentored research training.
Career Development

Significant barriers to the academic career development of clinical and translational scientists have been identified. Professionals in academic environments have significant demands on their time related to delivery of clinical care, teaching, and service expectations. Under these demanding conditions, it is challenging for professionals to carve out the time needed to pursue clinical and translational research. The multidisciplinary challenges of clinical research mandate a team-centered approach. Furthermore, clinical trials, which are often considered the gold standard for evaluating medical interventions, require significant resources and time to complete. Traditional measures of academic productivity (eg, scientific publications, grant funding) for scientists engaged in clinical trials are often lower than those of colleagues engaged in basic-science research. Academic promotion and tenure criteria are often based on the documentation of outcomes such as success as a principal investigator on extramural grants, number of peer-reviewed publications as first or lead author, laboratory leadership, and mentoring of junior investigators. These criteria are not easily met by CTS investigators participating in team-based clinical-trials research and may not even be optimal for evaluating their academic productivity. Therefore it is important that individuals pursuing translational research investigate support from administrators to ensure that they will be recognized for their efforts. Another barrier is the general lack of research training associated with professional development. Many professional training programs provide limited opportunities for basic research training, much less training opportunities for clinical and translational research. Early-career professionals entering academia are faced with time-limiting promotion and tenure expectations, resulting in limited opportunity to obtain requisite training in clinical and translational research. As such it is vitally important for rehabilitation scientists to seek opportunities to gain experience in the methodologies mentioned here and seek postdoctoral experiences that would solidify and provide additional opportunities to refine the skills learned in a CTS educational environment and likely establish the infrastructure to conduct clinical trials.

A third key component of the clinical and translational educational mission is to develop resources and programs to address the career development of clinical and translational scientists (eg, career-development resource toolbox). The development of platforms to educate and train clinical and translational scientists would be shortsighted if these scientists were not able to successfully pursue academic careers. NIH provides career-development resources in the form of training grants to institutions having a sufficient pool of academically strong trainees and commensurate experienced and well-qualified mentors along with resources for supporting academic career development. Resources are available for both predoctoral (T32) and early career (K12) development. The T32 predoctoral training resources are designed to provide predoctoral trainees with supplemental coursework and research training in clinical and translational research as part of their formal advanced-degree requirements. The K12 early career training resources support release time for professionals to participate in mentored research training and education designed to integrate previous professional training with research independence. Additional components of a well-equipped toolbox include academic survival-skill-development tools (eg, methods for training scientific writing skills for manuscripts and grants, budget and personnel management, time management); career guidance (eg, career counseling, support for retention and promotion); training in the responsible conduct of research,
including clinical research ethics; and mentor-training programs. The objective of these career-development resources is to expedite clinical and translational research in a context that will foster the academic discipline of CTS.

Integration of Rehabilitation Professionals

Rehabilitation professionals bring many skills to participating in and serving leadership roles in CTS. They work in a variety of settings and with a diverse group of patient populations. Settings may include inpatient, outpatient, hospitals, and home health delivery, and the patient population ranges from pediatrics to adults to the aging population, which includes those who are immobile and those who are highly physically active. The challenge for rehabilitation professionals is that the coordination of clinical trials demands specific training and understanding related to the organizational structure, processes, and paperwork necessary to see clinical trials to fruition. Likewise, access to or the ability to integrate basic-science findings with clinical research may be limited by the institution and the resources available. Educational opportunities in professional and postprofessional academic programs may not provide specific training in clinical translational research. Therefore, identifying academic programs via the NIH list of institutions that have CTSA grants is the first step for those interested in becoming more versed in this emerging research agenda.1 These programs provide the educational opportunities discussed here.

Rehabilitation professionals are clinically immersed in patient care, familiar with interdisciplinary health care, and skilled at working with multiple health care professionals. In fact, most rehabilitation professionals must coordinate the specific protocols of multiple health care providers when designing and prescribing rehabilitation programs. Similarly, rehabilitation professionals serve as the link between what has been studied in the laboratory and what is studied in the clinic. For example, in orthopedics/sports medicine, basic scientists may propose that healing rates are improved via a particular surgical technique. The surgeon uses this evidence to select a surgical procedure. The rehabilitation professional then studies the clinical recovery and function of the patient via the clinical rehabilitation and recuperation phases. Currently the International Classification of Functioning, Disability, and Health (ICF) model is often used to determine the efficacy of the proposed surgical technique.9 The ICF model of disability includes the domains of body structure, body functions, activities and participation, and environmental factors. These factors form the basis for evaluating patient progress. Based on these individual and societal perspectives, rehabilitation professionals provide verification of the outcome of the clinical procedure that was originally derived in the laboratory. The rehabilitation professional is poised to link clinical outcomes with basic science. Increased exposure of rehabilitation professionals to the CTS model will provide increased opportunities for the integration of basic and clinical science in the sport rehabilitation realm.

References


**Appendix: Certificate-Level Educational Competencies Outline—Training, Education, and Mentoring Core, Center for Clinical and Translation Science, University of Kentucky**

**I. Research Integrity (ethics and responsible conduct of research)**

A. Communication

1. Obtain informed consent.

2. Initiate discussions among study personnel to verify responsible conduct of research.

3. Respond to questions about research protocols in a manner that demonstrates knowledge of the responsible conduct of research.

4. Communicate potential violations of responsible conduct of research in a professional manner.

B. Professionalism

1. Protect human and animal subjects in accordance with appropriate institutional regulations.

2. Initiate discussions among study personnel to verify responsible conduct of research.

C. Critical Thinking/Synthesis of Knowledge

1. Evaluate ongoing research protocols for compliance with institutional regulations.

2. Examine procedures for maintaining data safety and integrity.

3. Recognize the potential for ethical problems in a proactive manner.
D. Planning/Management/Assessment
   1. Execute research protocols that meet the spirit of human subjects’ protection.
   2. Collect data using procedures that sustain data safety and integrity.
   3. Conduct data-processing activities in a manner that sustains data safety and integrity.

E. Leadership
   1. Respond in a timely manner to leadership requests for management of IRB/IACUC protocols.
   2. Demonstrate the ability to use project leadership strategies to work effectively with faculty and staff colleagues to facilitate responsible conduct of research.
   3. Recognize the chain of command with regard to violations of responsible conduct of research.

F. Teaching/Mentoring
   1. Demonstrate effective strategies for lifelong learning about issues affecting responsible conduct of research.

II. CTS Methods and Technologies

A. Communication
   1. Discuss strengths and limitations of major methodologies and technologies used in CTS.
   2. Articulate personal level of expertise and experience with regard to working with CTS methodologies and technologies.

B. Professionalism
   1. Independently describe the expertise required to implement CTS methodologies and technologies.
   2. Maintain appropriate degree of participation in CTS based on individual level of expertise.
   3. Demonstrate respect for diverse CTS methodologies and technologies.

C. Critical Thinking/Synthesis of Knowledge
   1. Consider opportunities for integrating methodologies and technologies into ongoing/planned protocols.
   2. Use computer software systems (word processing, spreadsheet, graphing, presentation) to support CTS protocols and data management.

D. Planning/Management/Assessment
   1. Integrate procedural knowledge of methodologies and technologies reflecting an individual’s level of expertise with other experts and CTS methodologies and technologies.

E. Leadership
   1. Respond in a professional manner to leadership requests for protocol development and management.
F. Teaching/Mentoring
1. Demonstrate effective growth over time that is indicative of self-assessment and effective lifelong learning of CTS methodologies/technologies.
2. Demonstrate effective information access and planning skills that enable productive lifelong learning of CTS methodologies/technologies.
3. Demonstrate effective information access and planning skills that enable continuous learning of procedural knowledge related to CTS methodologies/technologies.

III. Scientific Knowledge
A. Communication
1. Identify key elements of effective oral and written scientific communication.
2. Use key elements in making oral presentations reflecting strengths and limitations of methodologies and technologies.
3. Incorporate elements of effective scientific writing into written protocol descriptions.

B. Professionalism
1. Model the importance of effective communication (both speaking and listening) as a fundamental foundation for CTS research.

C. Critical Thinking/Synthesis of Knowledge
1. Synthesize knowledge of the strengths and limitations of CTS methodologies and technologies to effectively participate in project discussions.
2. Integrate procedural knowledge of CTS methodologies and technologies into written protocols.

D. Planning/Management/Assessment
1. Develop written protocols reflecting detailed descriptions of each team member’s activities in a given CTS protocol.
2. Develop effective communication systems to support the integration of multiple methodologies, technologies, and personnel into CTS studies.

E. Leadership
1. Establish a proactive and professional approach to sustaining effective communication with project leadership.

F. Teaching/Mentoring
1. Demonstrate growth over time that is indicative of self-reflection and effective lifelong learning toward effective communication skills.

IV. Measurement and Statistics
A. Communication
1. Describe the fundamental principles of scientific measurement.
2. Articulate the fundamental elements of statistics as applied to CTS protocols.
3. Initiate effective discussions among study personnel to establish that CTS protocols have effective measurement and statistical foundation.
B. Professionalism  
1. Require all CTS protocols to have effective measurement and statistical foundations.

C. Critical Thinking/Synthesis of Knowledge  
1. Organize data in spreadsheets to permit statistical analyses.  
2. Calculate summary statistics with data sets.  
3. Use existing software systems to create summary graphics from existing data sets.  
4. Execute statistical analyses as directed.

D. Planning/Management/Assessment  
1. Anticipate statistical and graphics needs when organizing data-collection and -management procedures.

E. Leadership  
1. Respond in a professional manner to leadership requests for statistical and data-analytic requests.

F. Teaching/Mentoring  
1. Demonstrate a sustainable commitment to ongoing improvement of measurement and statistical procedures for CTS protocols.

V. Collaboration and Team Building  
A. Communication  
1. Articulate the basic principles of effective teamwork.  
2. Adopt proactive approach to establish effective communication.

B. Professionalism  
1. Describe the importance and value of approaching clinical and translational research using a team approach.  
2. Demonstrate respect for team members.

C. Critical Thinking/Synthesis of Knowledge  
1. Examine ways for enhancing the effectiveness and cooperation among team members.  
2. Establish systems to support accurate and timely communication among CTS team members.

D. Planning/Management/Assessment  
1. Examine and incorporate methods and procedures for integrating methodologies and team-member activities into CTS protocols.

E. Leadership  
1. Respond in a timely manner to leadership requests for forming and supporting cooperation and teamwork.  
2. Demonstrate the ability to work effectively with faculty and staff colleagues to build teams of people with diverse talents, organizational positions, experiential backgrounds, disciplinary perspectives, and abilities.
3. Provide support for management of cooperation and teamwork in a professional and proactive manner.
4. Recognize the chain of command with regard to maintaining teamwork.

F. Teaching/Mentoring
1. Establish a proactive and professional commitment to developing and sustaining effective cooperation and teamwork in CTS research.