

Cleveland Clinic Lerner College of Medicine: An Innovative Approach to Medical Education and the Training of Physician Investigators

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Abstract

Cleveland Clinic Lerner College of Medicine (CCLCM) is an innovative, five-year medical education track within Case Western Reserve University School of Medicine (Case) with a focused mission to attract and educate a limited number of highly qualified persons who seek to become physician investigators. CCLCM curriculum governance, faculty appointments and promotions, and admissions committees are integrated with respective Case committees. The CCLCM curriculum is based on faculty-defined professional attributes that graduates are expected to develop. These attributes were used to create curricular and assessment principles

that guided the development of an integrated basic science, clinical science, and research curriculum, conducted in an active learning environment. An organ-system approach is used to solidify an understanding of basic science discipline threads in the context of relevant clinical problems presented in PBL and case-based discussion formats. Clinical skills are introduced in the first year as part of the two-year longitudinal experience with a family practice or internal medicine physician. The research program provides all students with opportunities to learn and experience basic and translational research and clinical research before selecting a

research topic for their 12- to 15-month master-level thesis project. All Case students participate in required and elective clinical curriculum after the second year, but CCLCM students return to the Cleveland Clinic on selected Friday afternoons for program-specific research and professionalism-learning activities. A unique portfolio-based assessment system is used to assess student achievements in nine competency areas, seven of which reflect the Accreditation Council for Graduate Medical Education competencies.

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In 1979, James Wyngaarden, MD, who was then director of the National Institutes of Health (NIH), first focused the nation's attention on the emerging problem of the "clinical investigator as an endangered species."¹ Since that time, several reports by notable authors and distinguished panels have echoed this concern, but the trend of decreasing numbers of MDs pursuing careers as physician scientists has continued.^{2–5}

Recognizing the critical role that the physician scientist plays in translating advances in basic science to bedside application, and in converting clinical observation into relevant research

questions, the NIH, under the leadership of its current director, Elias Zerhouni, MD, has embarked on a multipronged approach to address this crisis through its Roadmap Initiative. This program has focused primarily on opportunities made available to support the career development of postgraduate MDs interested in pursuing careers in translational and clinical research. In part, this approach addresses the fact that few medical schools have targeted their educational and curricular focus on increasing the pool of MD graduates specifically trained to be translational or clinical investigators.

In recognition of this challenge and in keeping with its strength in translational and clinical research, the Cleveland Clinic decided to establish a new medical school curriculum focused on the training of physician investigators. After deliberation, a decision was made to pursue this program in collaboration with Case Western Reserve University, and a formal affiliation was established in 2002 to create Cleveland Clinic Lerner College of Medicine (CCLCM) of Case Western Reserve University. In this article, we detail the structure of CCLCM and the process used to design and implement this unique new initiative

with the inaugural class that entered in the summer of 2004.

The establishment of CCLCM provided a rare opportunity to create a medical school program with a focused research mission from a clean slate. As articulated by institutional leadership, the mission of CCLCM is to train physician investigators and scientists who will advance biomedical research and practice. This mission served as the foundation for educational principles that guided all program development efforts. Unburdened by an existing curriculum, the faculty designed every aspect of this initiative, including curricular structure, course content, assessment process, faculty mentorship system, and educational philosophy, to achieve this purpose. Substantial efforts were expended early in the planning process to benchmark with other medical schools that required research and/or used curricular models, such as PBL, that aligned with CCLCM's stated core principles, with methods used to train MD fellows in clinical research (e.g., NIH K30 program and various master in clinical research programs), and in particular with competency- or ability-based curricula and student assessment models in existence at the time (2002 to 2003). By combining site visits to other schools and inclusion of educational

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leaders in program planning retreats, a wide range of possible approaches to achieving the educational missions were explored, discussed, and either incorporated or rejected for both educational and practical reasons. For example, the decision to develop a five-year curriculum derived in part from knowing the high percentage of students at schools requiring a thesis who stayed an additional year to complete the traditional four-year curriculum and finish their research projects.

Administrative Structure

CCLCM is a distinct educational track within the Case Western Reserve University School of Medicine (Case) as defined by the Liaison Committee on Medicine Education (LCME).⁶ A process for ensuring compliance with LCME accreditation standards, with appropriate oversight by Case, was specified in the affiliation agreement between Case Western Reserve University and the Cleveland Clinic, with details of each aspect developed during the first year of the affiliation. The Cleveland Clinic bears full financial responsibility for CCLCM with revenues generated from tuition, gifts, grants, and clinical operations.

All administrative staff and the majority of year one and year two faculty for the CCLCM curriculum are full-time salaried staff of the Cleveland Clinic. During years three through five, students may interface with a broad range of clinical faculty and research faculty from all affiliated institutions. The CCLCM executive dean is responsible for all aspects of the program and reports to the dean of Case for academic matters and to the Cleveland Clinic chief of staff for administrative matters.

CCLCM and Case have developed a unique oversight structure to address the administrative needs of the new program. Students apply through AMCAS to Case and can select the CCLCM program, the traditional university program, or both. The CCLCM admissions committee reviews and interviews applicants and recommends admission to the CCLCM program with oversight approval by the Case admissions committee. The CCLCM medical student promotion and review committee determines student advancement and reports decisions to the Case committee on students. The

CCLCM appointments and promotions committee recommends faculty appointments and promotions to the Case committee on promotions, appointments, and tenure. Criteria for appointment and promotion are the same as those for all other Case faculty. Academic departments and faculty for CCLCM are represented on Case faculty committees, such as the faculty senate. Curriculum planning, implementation, and evaluation are coordinated by the CCLCM curriculum steering council that reports to the Case committee on medical education. The oversight structure has worked well to facilitate the ability of CCLCM program faculty to develop a unique educational program within the established governance structures of Case Western Reserve University and the Case School of Medicine.

A limited LCME site review of Case was conducted in fall 2004 with a very positive review of the new CCLCM program. An update was requested by and provided to the LCME in the fall of 2006, and the CCLCM program will be reviewed as part of the next scheduled full Case LCME review in 2008.

Program Design

To ensure achievement of a focused, mission-based goal, a curriculum development task force, which comprised physicians from multiple specialties and basic science researchers from the Cleveland Clinic, met in a series of retreats to define the professional attributes that should be developed in program graduates. Task force members found the following attributes to be critical contributors to the professional success of a physician investigator: independent, critical thinking; self-directed learning; being a team player; scientific inquiry; broad-based research knowledge; strong clinical skills; and reflective practice. Striving to achieve these traits in program graduates provided important creative direction for CCLCM's curriculum development efforts.

The faculty then developed the following set of core curricular principles that would guide program design: a graduate education model; interactive seminars, no lectures; student-centered learning; assessment to enhance learning; competency-based performance evaluation; and integration of research, basic science, and clinical experience. CCLCM's mission

statement was carefully crafted and used as a basis for all decisions about curriculum design.

CCLCM's mission or overarching curricular goal was to "foster a passion for scientific inquiry and skills for critical thinking coupled with broad-based clinical expertise to optimally position the MD graduate to pursue a career as a physician investigator." This meant creating an active learning environment that would be intellectually stimulating and maintain student enthusiasm for learning. The curriculum design was based on the experience of the faculty members involved in its planning and on positive outcomes of other curricular models⁷⁻⁹ and principles of adult learning. Lectures, considered a more passive approach to learning, were strongly discouraged. Instead, the curriculum was designed with PBL sessions as the foundation for each week's theme, supplemented and complemented by opportunities for discourse with content experts during small-group interactive seminars (approximately half of the seminar sessions are conducted in groups of 8 or 16 students, and the remainder are for the whole class of 32; all sessions use case-based problem-solving techniques rather than lectures, to encourage student preparation and participation), journal clubs, clinical correlations, and laboratory experiences. This experience was designed to emulate a graduate education environment in which student preparation for interactive discussion is essential and knowledge acquisition, rather than test preparation, is the focus. A class size limited to 32 students helps to ensure that all educational sessions are student centered and provide opportunity for interchange. Students are reorganized in PBL and seminar groups four times in years one and two to provide students with the opportunity to work with all other students and to learn to organize and function as an effective team.

Curriculum Overview

Integration of research, basic science, and clinical experience was a high priority to the curriculum planners to ensure that students learned and applied basic science concepts in the context of clinical medicine (Figure 1). In part, this was ensured by identifying physician faculty as organ-system course directors

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8:00 am - 10:00 am	Problem Solving Session	Focused Topic Session	Problem Solving Session		Problem Solving Session
10:00 am - 12:00 pm					Journal Club
12:00 pm - 1:00 pm					
1:00 pm - 5:00 pm		Research Experience			

Figure 3 A sample week of the basic and translational research block, summer, year one, Cleveland Clinic Lerner College of Medicine of the Case Western Reserve University, Cleveland, Ohio.

Research Education

A unique aspect of CCLCM is the formal research curriculum extending from year one to graduation. The first two summers of CCLCM provide a foundation for the research curriculum (Figure 3). In the year one summer, students participate in a basic/translational research project and give an oral scientific presentation detailing their work. Under the guidance of their research preceptor, they draft a mock grant proposal to begin developing the critical-thinking and writing skills necessary for hypothesis-driven research. The weekly basic/translational research journal club is geared toward helping students develop the skills necessary to review the scientific literature critically and toward honing their oral presentation skills. Weekly seminars and labs in the Fundamentals of Molecular Medicine course ensure student exposure to core basic science concepts and topics they might not encounter in their own summer research lab experience.

The year two summer focuses on clinical research training. Students participate in a clinical research project with a clinical investigator mentor and complete daily coursework covering a broad range of topics in epidemiology and biostatistics, as well as ethical issues pertinent to the responsible conduct of clinical research and protection of human participants, including IRB exposure. Similar to the first summer, students develop a mock grant proposal under the direction of a clinical research preceptor, this time focused on a hypothesis-driven clinical research topic with an oral presentation detailing the proposal at summer's end. Weekly journal club sessions focus on

seminal articles in the clinical research literature.

The research curriculum extends beyond the summer experience in years one and two through several curricular components integrated with each week's basic science curricular theme. A weekly Process of Discovery seminar series provides students with exposure to a broad range of basic, translational, and clinical investigators who discuss their area of research interest. These seminars provide the opportunity to extend learning beyond currently accepted textbook knowledge and foster exposure to potential mentors and areas of research that students may wish to pursue for their research theses. A similar approach is taken in quarterly dean's dinners where senior physician investigators discuss their research in an informal setting with all 32 students in the year one or year two class, followed by dinner and discussion of the investigators' career paths. Research-related questions are addressed in PBL cases, and many basic science seminars extend current knowledge content to the latest research findings. During years three through five, students return to a biweekly half-day research seminar series regardless of their clinical rotations, with topics partly focused on extending their clinical experience towards scientific inquiry of unanswered clinical questions.

Research training culminates with student achievement of a formal master-level research thesis. Each student is required to complete a 12- to 15-month mentored research project, including preparation and defense of his or her thesis. Research mentors work with their mentees to ensure that students develop an

achievable, hypothesis-driven research proposal and make appropriate progress in their research. The research education committee helps to ensure appropriate matching of students with mentors. Time allocated for research can be flexibly scheduled as a large block or in shorter segments to meet the needs of each student's research. During allocated research time, however, all students are required to spend a half day each week in a related clinical experience to ensure maintenance of a clinical perspective to their research. In recognition of the rigor of the CCLCM research curriculum, all students at the CCLCM will graduate from Case with an MD with special qualification in biomedical research.

Competency Assessment: Educational Portfolios

CCLCM's system for student assessment was developed with a commitment to reinforcing the goal of fostering self-directed learning and reflective practice. The philosophy underlying the assessment system is that assessment must enhance learning (List 1). There are no grades and no class ranking system. Instead, students receive frequent formative feedback regarding their performance in nine areas of core competency (List 2) from multiple sources, including weekly multiple-choice self-assessment questions; weekly essays requiring integration of core basic science concepts; feedback based on direct observation from clinical preceptors, PBL facilitators, journal club preceptors, and research preceptors; and OSCEs with standardized patients. To encourage students to think of learning as a continuum, no final course exams are given. Individual student performance is measured against standards set by the faculty for each competency, with the intended goal of achieving appropriate levels of performance in each of nine competencies by the end of medical school. Students meet with their physician advisers (see below) on a regular basis to review their evidence of performance and develop learning plans to address areas identified as needing improvement. Without grades or class rank, the system promotes a noncompetitive learning environment that fosters collaboration and team-based learning while training students to take individual responsibility for

List 1

Principles of Student Assessment, Cleveland Clinic Lerner College of Medicine of the Case Western Reserve University, Cleveland, Ohio

- Assessment will enhance learning.
- Self-assessment and reflection are critical components of the assessment process.
- Students will receive frequent feedback from multiple sources.
- Students will work in partnership with faculty advisers to identify individual strengths and weaknesses.
- Performance measurement will be competency-based with defined standards of achievement for each competency.
- Educational portfolios will be used to document student progress.

understanding and addressing their own strengths and weaknesses.

In place of grades and class rank, each student maintains an educational portfolio to document evidence of his or her individual progress in each of the nine areas of core competency.¹¹ Students receive training about the portfolio system and the elements of useful feedback during medical school orientation and in several class meetings. They also receive regular feedback about their portfolios from their physician advisers. Physician advisers formally review portfolios with their students on

a regular basis for formative assessment purposes (three times in year one, two times in year two, and once a year in years three and four), and the medical student promotion and review committee reviews portfolios for summative purposes (at the end of years one, two, and five). This competency-assessment process is a natural transition to performance assessment in residency training, and seven of the nine core competencies for which CCLCM students are assessed directly map to those mandated by the Accreditation Council for Graduate Medical Education for assessment of residents (research and

personal development are additional competencies at CCLCM) (List 2).

Advising System

Key to the success of this portfolio-based competency-assessment process is the student advising system. Each student has a physician adviser with whom he or she works in partnership for five years. Physician advisers meet regularly as a group to ensure a uniform approach to assessing student performance and advising student progress. The physician advisers have electronic access to all feedback regarding the performance of their advisees. Each student's formative portfolio includes an individualized learning plan that the advisers must approve to ensure that students are accurately identifying their strengths and weaknesses. In the clinical years, this system will allow advisers to follow student performance during each clinical discipline, as well as across disciplines, to ensure progress in discipline-specific clinical skills as well as in competencies that cross disciplines, such as professionalism and communication skills.

Each student selects a research thesis adviser sometime after the second research summer; the research adviser is expected to ensure that the student develops an achievable, hypothesis-driven research proposal and makes appropriate progress during his or her 12 to 15 months of research. The research adviser, the physician adviser, and the student collaborate to tailor the student's curriculum during years three through five to achieve his or her individual learning and research goals.

List 2

Core Competencies about which Students Receive Formative Feedback and Assessment, Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, Cleveland, Ohio

- **Research:** Demonstrate knowledge base and critical-thinking skills for basic and clinical research, skill sets required to conceptualize and conduct research and understand the ethical, legal, professional, and social issues required for responsible conduct of research.
- **Basic and Clinical Sciences of Medical Knowledge*:** Demonstrate and apply knowledge of human structure and function, pathophysiology, human development, and psychosocial concepts to medical practice.
- **Communication*:** Demonstrate effective verbal, nonverbal, and written communication skills in a wide range of relevant activities in medicine and research.
- **Clinical Skills*:** Perform appropriate history and physical examination in a variety of patient-care encounters and demonstrate effective use of clinical procedures and laboratory tests.
- **Clinical Reasoning*:** Diagnose, manage, and prevent common health problems of individuals, families, and communities. Interpret findings and formulate action plan to characterize the problem and reach a diagnosis.
- **Professionalism*:** Demonstrate knowledge and behavior that represent the highest standard of medical research and clinical practice, including compassion, humanism, and ethical and responsible actions at all times.
- **Personal Development:** Recognize and analyze personal needs (learning, self-care, etc.) and implement plan for personal growth.
- **Health Care Systems*:** Recognize and be able to work effectively in the various health care systems to advocate and provide quality patient care.
- **Reflective Practice*:** Demonstrate habits of analyzing cognitive and affective experiences that result in identification of learning needs leading to integration and synthesis of new learning.

*These competencies map to the six Accreditation Council for Graduate Medical Education competencies required of accredited U.S. residency training programs: patient care, medical knowledge, practice-based learning, communication skills, professionalism, and system-based practice.

Faculty Development

An essential component of implementing a new curriculum is assuring that faculty members not only are well prepared to conduct educational and administrative activities (such as admissions, physician advising, and research precepting) but also understand and articulate the program's principles and goals as they carry out their activities. This is particularly important for CCLCM because it is a new curriculum, conducted in a new setting, and is based on unique, innovative curriculum and assessment principles. Faculty fill multiple roles (see CCLCM Web site (<http://www.clevelandclinic.org/cclcm>))

for role descriptions), including physician advisers for the 95 students currently enrolled, members of the medical student promotions and review committee, basic science and clinical research preceptors each summer, PBL facilitators, and year one and year two longitudinal clinical preceptors, in addition to the course directors and other teaching faculty.

Faculty are recruited with the understanding that their departments will be reimbursed for release time required for administrative roles and that teaching and administrative activities related to CCLCM will be recognized at the time of the faculty member's annual performance review. Faculty are therefore expected to participate in faculty retreats and faculty development workshops to acquire the necessary skills to succeed in their multiple roles. In addition to retreats and workshops, direct observation of faculty teaching methods by trained educators and more experienced faculty is encouraged to assist all faculty in further developing their skills.

Program Evaluation

To ensure that this new curriculum adheres to its principles and mission, CCLCM faculty designed a comprehensive program evaluation system aimed at systematically providing a critical review of the program's strengths and weaknesses. Course directors' weekly feedback sessions are used for just-in-time monitoring of course quality. In these sessions, PBL facilitators summarize student perceptions and faculty members report on course activities during the past week. More formal, end-of-course evaluation reports are used to refine course design for subsequent courses. Course directors report on evaluation results to the CCLCM curriculum steering council, presenting evaluation results and plans to address areas of curricular weakness. Feedback regarding educational portfolios themselves is also collected to help refine the student assessment system. In addition, program evaluation data are used to direct faculty development sessions targeted to improve specific teaching and assessment skills (e.g., writing narrative performance assessments, facilitating interactive seminars). All program evaluation data are organized in a database that will be used for educational outcomes research as approved by the Cleveland Clinic's IRB. In the hands

of a faculty seeking continuous quality improvement, this approach has resulted in a fluid curriculum that can readily respond to critique and build on areas of strength as appropriate. Student assessment and program evaluation data will be collected throughout the five-year curriculum, and postgraduation assessments from residency program directors and career paths of program graduates will eventually be monitored to track program success in achieving its curriculum mission and goals.

Information Technology

The success of the CCLCM program is a result of the creativity of the faculty as well as the development of a robust electronic infrastructure to support the curriculum and assessment process. All students are provided a laptop computer to facilitate access to the CCLCM curriculum and computer-based resources that encourage student inquiry and learning. As part of the clinical education curriculum, the system allows students to maintain patient logs and receive competency-specific encounter-based feedback from faculty to refine their clinical skills. The system creates an electronic database of faculty assessments and feedback regarding student performance from which students select evidence for their formative and summative portfolios. This electronic infrastructure has been critical to the successful implementation of the CCLCM curriculum by facilitating each student's ability to be responsible for his or her own learning and achievement of core competencies as defined by the program.

Summary

Medical school is the first step in a long continuum to residency training and professional practice. Although board examinations and recertification tests are currently necessary hurdles used to ensure achievement of minimum standards of competency, self-directed learning fostered by reflective practice is essential to ensure continued professional growth and achievement of the highest levels of professional competency.¹² These skills are critical for all practitioners of medicine as well as for those pursuing careers as investigators in the field of medicine, which is so rapidly advancing.

The goal of the CCLCM program is to ensure that its graduates will be reflective

practitioners of medicine and science whose drive for lifelong learning and scientific inquiry will be complemented by a critical approach to continuous self-assessment and self-improvement. Although the primary mission of other medical schools is not necessarily focused on training physician investigators, the educational approach developed for CCLCM is pertinent to the training of all physicians. Lecture-based curricula with graded examinations and class rankings less readily foster self-directed learning and reflective practice. Rather, lectures direct students to what they should know, and passing grades set minimal levels of achievement required for progress. Unfortunately, the transition to residency from this traditional educational approach is abrupt, as interns must be responsible for understanding their own limitations and strengthening their areas of individual weakness. Such skills are of even greater importance for practicing physicians and researchers, challenged by the constantly changing face of medical science and therapeutics.

For many physicians, reflective practice is an uncomfortable concept for which they are ill prepared. An educational environment in medical school that fosters such skills is an important first step to professional success. The educational tenets underlying the design of CCLCM are derived, in part, from other programs in diverse educational fields. In aggregate, they comprise a unique approach to medical education that can perhaps serve as a model for future curricular reform at other medical schools similarly interested in this direction of student professional development.

The academic cooperation between physicians and scientists across the entire CCLCM curriculum has resulted in several curricular enhancements. Importantly, basic science concepts are learned in the context of clinical relevance, and relevant basic science is the curricular focus. An invaluable bonus has been the communication and cooperation between disparate faculty and the establishment of cross-discipline relationships that have the potential for productive future collaboration.

Future measures of program success will be the career paths of CCLCM graduates. The first challenge will be to help ensure

that graduates successfully compete for academic residencies that foster further development and application of research skills. The unique assessment process used at CCLCM will require faculty and program leadership to ensure that GME program directors understand the strengths and talents of CCLCM graduates. To date, anecdotal feedback from leaders in medical education suggests that the competency-based assessment model used at CCLCM should provide valuable, individual-specific data that will be welcomed by residency directors as important complements to USMLE scores. In addition to the significance that residency directors place on USMLE scores, the scores also provide a national measure of program success. We note that the first class of students recently completed the USMLE Step 1 and all passed at a level substantially above the national mean.

The CCLCM five-year curriculum differs distinctly from MD/PhD programs, although both seek to train scientific investigators. Rather than the more narrow focus of MD/PhD programs in which students' in-depth research experiences are typically segregated from standard medical school coursework, CCLCM provides a broad foundation of research training and experience integrated throughout medical school. This provides students the opportunity to apply their research skills to any area of clinical medicine they decide to pursue. Data suggest that fewer than a third of MD/PhDs eventually maintain academic careers in research.¹³ Only time will tell whether the CCLCM's curricular approach will result in greater success than current MD/PhD program structure in yielding practicing physicians involved in scientific investigation.

CCLCM also serves as an alternative model for expanding the capacity of undergraduate medical education as called for by the Association of American Medical Colleges.¹⁴ Rather than increasing class size in a single program, this model provides an alternative track for training students by using the unique strengths of an academic medical center in partnership with an existing medical school. At Case, adding this new educational track increased the projected number of graduates in 2009 and beyond by approximately 22% without straining the educational resources of the existing program. The model increases opportunities for medical students while addressing a specific need in medical education.

Tomorrow's physician investigator must have the skills necessary to translate the tremendous explosion of basic science advances into clinical practice. This will require not only an in-depth understanding of basic science and clinical medicine, but also the skills to bridge these disciplines through scientific inquiry with practical application. We hope that graduates of CCLCM will be well prepared for this challenge.

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