

A Practical Approach to Master's Level Clinical Laboratory Science Education

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ABBREVIATIONS: Clinical Laboratory Science (CLS), Master of Science (MS), Bachelor of Science (BS), University of Tennessee Health Science Center (UTHSC). Medical Technology (MT), Medical Laboratory Technicians (MLT), Grade Point Average (GPA), Advanced Practice (AP)

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INTRODUCTION AND RATIONALE

In 2002, Beck and Doig surveyed laboratory managers, educators, practitioners and students to assess the need for a career entry-level Master of Science (MS) degree in Clinical Laboratory Science (CLS). Survey results indicated that educators, practitioners and managers agreed that the scope of CLS practice did not warrant an entry-level MS degree. Students, however, indicated that they would be interested in an entry-level MS in CLS if it led to higher pay and additional job opportunities. Students with a previously earned

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baccalaureate degree expressed more interest in the entry-level MS than those without the degree. The authors suggested that in an era of laboratory manpower shortages, clinical laboratory science educators should consider multiple career entry choices to attract potential students into the profession.¹ Li et al determined that clinical laboratory practitioners with advanced degrees had higher salaries, greater job mobility and increased management authority. Master of Science degree recipients had authored more external publications and made significant professional contributions as compared to their baccalaureate level colleagues.²

In July 2005, the American Society for Clinical Laboratory Science (ASCLS) commissioned a task force to examine practice levels and the educational needs of clinical laboratory personnel. Development of a comprehensive career ladder was among the goals of the task force. The new practice model will help establish new standards of practice through a national career ladder model with multiple points of entry and advanced levels of practice.^{3,4}

The University of Tennessee Health Science Center is an academic health science center that offers health education programs in medicine, dentistry, nursing, pharmacy, and allied health sciences. Students take pre-requisite courses at other colleges and universities. The Department in Clinical Laboratory Sciences offers a BS degree in Medical Technology and a post-professional MS in Clinical Laboratory Science. The UTHSC baccalaureate degree program in medical technology is a 2 + 2 program that is 21 months in length with clinical rotations integrated throughout the curriculum. Program capacity is 20 students in each year of the program. Potential applicants to the MT program are recruited from area colleges and universities. Competition exists for good science students and the faculty and advisors of the "feeder institutions" are reluctant to promote the UTHSC medical technology program because of the potential loss of students and tuition dollars. As the number of applicants for the Medical Technology program decreased, multiple options for attracting students were considered. These included an option for medical laboratory technicians (MLT) to complete a BS degree in MT. While that option does improve the skills and training of individuals, it does little to alleviate the personnel

CLINICAL PRACTICE

shortage since it does not increase the number of laboratory practitioners in the field. Online programs were considered but the faculty discussed the difficulty of teaching the visual arts of hematology and microbiology online and there was concern about maintaining the program's high standards. The faculty also discussed the practice in universities of having bachelor/master students or master/doctoral students enrolled in the same course with additional assignments made for the higher degree.

Medical Technology program officials noted that often the entering medical technology students had previously earned a BS degree in the sciences. (Table 1) Many qualified potential applicants expressed an unwillingness or the financial inability to complete a second baccalaureate degree but were enthusiastic about pursuing a graduate degree. On inquiry, it was found that additional financial aid is available to students in graduate programs.

Upon consideration of all these factors, the University of Tennessee Health Science Center (UTHSC) Program in Medical Technology developed an option for students who have earned a baccalaureate degree in biology, microbiology or chemistry from a regionally accredited college or university and desire national certification as a MT/CLS.

The career entry-level Master of Science program graduates laboratorians with advanced practice skills and provides value-added graduates in the workforce. Despite the lack of broad support nationally to change career entry practice from the BS to the MS level, there is need for graduates who can think critically and who can apply higher level cognitive skills to today's problems. Although career entry-level salaries are similar for both the BS and MS graduates, UTHSC medical technology faculty anticipated that the "value-added graduate" would be recognized early in their career and that employers would see the potential of these graduates to assume leadership roles in the laboratory. Furthermore, the chance to ascend a career ladder could lead to job enrichment and retention of practitioners in the medical laboratory profession.

CURRICULUM PLAN

UTHSC program officials consulted with the CLS faculty of Rush University, Chicago, IL and Louisiana State University Health Science Center, New Orleans, LA where similar programs existed and thrived.^{5,6} With the advice and the experiences of faculty in these programs, the UTHSC BS curriculum was modified to include graduate level content.

Students in the new career-entry option earn a Master of Science in Clinical Laboratory Science following 24 months

Table 1. UTHSC Enrollment Data
BS Program in Medical Technology – 21 months
MS in Clinical Laboratory Science Program – 24 months

	Class entering									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Applicants	17	14	22	35	17	29	27	39	36	
Enrolled	7	6	12	18	13	15	11	17	17	
Previously Earned B.S.	4	2	7	5	3	7	5	8	9	
% with BS	66%	33%	58%	31%	27%	58%	55%	57%	53%	
BS MT Graduates	6	6	12	16	11	5	4	8		
MS in CLS Graduates						7	5	6		

of study.⁷ Students interested in the MS degree apply for admission to the BS program initially. In addition to their BS degree requirements, qualified applicants must meet requirements for admission to the BS program including successful completion of a minimum of 30 pre-requisite semester hours in the math and science courses that are required for medical technology students in the state of Tennessee. (Tennessee law requires medical laboratory personnel, facilities and training programs to be licensed.) After admission to the program, students who desire entrance to the MS program take all courses with BS students and must complete forty-four (44) semester hours of the undergraduate professional medical technology courses. A cumulative GPA of 3.0 or higher on a 4.0 scale must be maintained for a student to be considered for admission to the MS program. The professional behavior of these students based on performance in classes and student labs is assessed by the faculty. The evaluation includes attendance, punctuality, attitude, adherence to policy, class participation, and timeliness of assignment completion. Additionally, students eligible for the MS program write a short essay expressing their desire to change their status from BS to MS and a willingness to perform the extra assignments involved. There is no mechanism for returning to the BS status, so students are made aware of this policy and sign a contract attesting to their understanding. Students who have successfully met these requirements are admitted to the Advanced Practice (AP) track in the Medical Technology program beginning in the second year. (Table 2)

Second year courses focus on a case-based approach to laboratory medicine and patient care as laboratory data is integrated across disciplines with patient history and physical findings. Master's level courses are taken with the BS students in the second year but have higher cognitive level learning objec-

tives to improve the learner's critical thinking and problem solving skills. To achieve these objectives, graduate students have additional assignments in each didactic course and clinical rotation. These assignments include, but are not limited to: additional reading assignments, essay type test questions, journal article critiques, case study presentations, research papers and independent learning assignments. Advanced Practice (AP) graduate students complete all BS coursework and have additional learning opportunities in management and education with online exercises. The Molecular Diagnostics course for AP students includes two weeks of clinical experience in molecular laboratories instead of the one week requirement for BS students. In the research methods course, students critically analyze current journal articles and are given additional writing assignments. Advanced Practice graduate students have the opportunity to develop presentations and improve their presentation skills. For example, in Hematology, each student must determine a diagnosis based on case history and differentials on peripheral blood and bone marrow specimens. They prepare a case presentation for fellow students and faculty. While on their clinical rotation in the hematology laboratory, graduate students are required to present their hematology case study as a continuing education session for the hematology laboratory staff at their rotation site.

During the Winter/Spring semester of the second year, graduate students begin work with a faculty mentor on a four-week Master's level project which is subsequently written in a format suitable for publication in a clinical journal. Projects are presented to faculty and fellow students upon completion. Having met all the requirements for national certification examinations and laboratory personnel licensure in Tennessee in late summer, graduate students are eligible for employment.

PROGRAM CONCERNS AND SOLUTIONS

Implementation of a novel program and curriculum has not been without issues.

1. Concerns were expressed by the UTHSC Registrar and Financial Aid officials. UTHSC Registrar's Office staff was concerned that while initially enrolled in the BS in medical technology program, students who met the criteria for the AP track were shifted to the MS program after 12 months. Different course numbers and course descriptions had to be developed for the MS level courses. Frequent communication with the Registrar and her staff over the past two years, including providing a list of students accepted in the AP

Table 2. UTHSC requirements to enter the MS in CLS advanced practice program

1. An earned BS degree in biology, chemistry or a related field including all pre-requisite courses
2. Cumulative GPA of 3.0 or higher in first year BS medical technology coursework
3. Letter of intent to enter the MS in CLS AP program
4. Signed acknowledgment of the requirements of students in the graduate program
5. Positive faculty assessment of professional behavior

CLINICAL PRACTICE

track and a list of specific courses in which they are enrolled each semester, has minimized problems. Initially unknown to program officials, graduate students must be enrolled in 9 semester hours or more to receive federal financial aid so the second year summer/fall semester was developed with 10 semester hours to allow qualified students to receive federal financial aid.

- Originally, first year clinical rotation grades were included in the GPA calculations of the AP class which allowed two minimally qualified students with borderline GPAs to enter the MS program. When it was realized that there was limited consistency in the clinical laboratory experience as far as testing of students and types of patient specimens encountered, the decision was made not to include the rotation grades in the GPA requirement for the AP program. Currently, the students' cumulative GPAs are considered after the first two semesters of didactic courses which include lecture and student lab.
- After the second year of the program it was decided that an assessment of student's professional behavior and attributes should be completed by the didactic faculty to assure that students demonstrate the acceptable professional demeanor required of a graduate student in clinical laboratory science.
- Clinical instructors discussed feeling a bit threatened by career entry-level MS students. They expressed concerns that new graduates with a MS degree might command higher entry-level salaries and voiced apprehension that new MS graduates would become laboratory supervisors early in their career. MT program faculty assured them that the MS graduates were career entry-level technologists and that they needed 4 years of clinical experience and continuing education to become eligible for a laboratory supervisor license in the state of Tennessee. Dialogue among laboratorians, lab managers and program educators has alleviated the concerns of the clinical instructors and laboratory staff.
- Still being considered are the questions of the program's recourse if a graduate student does not maintain a GPA of 3.0 or higher while in the program or if a graduate student demonstrates a lapse in professional conduct. At this time, students will be considered by the progress and promotions committee of the program on a case-

by-case evaluation.

- The Graduate Record Examination (GRE) is under consideration as a requirement for the MS in CLS Advanced Practice program.

OUTCOMES

Since the acceptance of the first group of students into the AP program in 2006, support and approval has been strong with positive outcomes in the quality and quantity of applicants. There has been wide acceptance for the MS in CLS Advanced Practice Program from faculty and advisors from feeder institutions and these individuals now recruit students for the program. The opportunity for students interested in laboratory science to obtain a Master's degree has led to an increase in viable applicants, near capacity enrollment and an alternate list of candidates into the program. Scores of AP graduates on national registry examinations have been >9% higher than BS students in the two classes that have graduated. (Table 3) Laboratory managers and supervisors have noted the potential for the MS in CLS graduates and have promoted some to higher level positions, such as the MT II level, with only one year of experience instead of the 2-3 years usually required of a BS medical technologist. Graduates of the AP track have had job opportunities in laboratory information systems, point of care testing coordination, compliance and higher education.

CONCLUSION

Development of the career-entry Master of Science in Clinical Laboratory Science Advanced Practice program at the University of Tennessee Health Science Center has proven its worth in a brief time. The offer of a MS degree in CLS has led to greater student interest, increased enrollment and employer acceptance and support. Future plans include a survey of employers of AP graduates to determine if a difference in BS and MS prepared clinical laboratory scientists exists, as well as a survey of the AP graduates themselves to assess their preparation and readiness to assume laboratory leadership roles. As noted previously, during a time of national laboratory workforce shortage, a choice of career entry

Table 3. Mean certification exam scores

	Graduates	
	2007	2008
ASCP BOR-BS	463	525
ASCP BOR-AP	585	565
% difference	9.5%	9.3%

CLINICAL PRACTICE

options helps draw potential students and prepare them for their careers in the 21st century clinical laboratory.

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