Graduate Education in Clinical Laboratory Science
Is the Glass Half Full or Half Empty?

KAREN KARNI, JOAN POLANCIC, JOANN FENN, DONNA J. SPANNAUS-MARTIN

OBJECTIVE: To evaluate the 2007 and 1990 data on the number and characteristics of programs offering graduate level degrees in Clinical Laboratory Science.

DESIGN/SETTING/PARTICIPANT: Data were collected from published sources (Directory of Graduate Programs for Clinical Laboratory Practitioners) and analyzed at the University of Minnesota. Specific data regarding the kinds of advanced programs and the number of graduates per year, the number of program openings and closures, program requirements were collected, as well as data regarding the number and employment of graduates of Master's degree programs at two long-standing public institutions.

INTERVENTION: Not Applicable.

MAIN OUTCOME MEASURE: The tabulation of degree, program, and graduate data, together with the first position taken by graduates of two M.S. programs.

RESULTS: The numbers of graduate level programs and graduates decreased between 1990 and 2007, from 39 to 28 identified Master's level programs, but with only a slight increase from two to five doctoral programs. Several prominent and historically important Master's level programs have closed since the first edition (1990) of the Directory. Detailed analysis of the data from two Master's level programs showed that the first positions for graduating students were predominantly research related and in the same state as the degree-granting institution.

CONCLUSION: The number of advanced programs and graduates are relatively small in clinical laboratory science; however M.S. graduates are successful in obtaining positions. These positions are predominantly geographically related to the degree-granting institution, indicating an intellectual and economic impact of the programs in the regions they are located.

ABBREVIATIONS: ASCLS = American Society for Clinical Laboratory Science; CLS = Clinical Laboratory Science; ASMT = American Society for Medical Technology; TOEFL = Test of English as a Foreign Language.

INDEX TERMS: Clinical Laboratory Science; Graduate Education; Health, Manpower; Laboratory Personnel; Students, Health Occupations.

Karen Karni, PhD, CLS(NCA), University of Minnesota, Program in Clinical Laboratory Sciences, Minneapolis, MN 55455

Joan Polancic, MSEd, MLS, American Society for Clinical Laboratory Science (ASCLS), Bethesda, MD 20817-1574

JoAnn Fenn, MS, MT(ASCP), Medical Laboratory Science, Department of Pathology, University of Utah School of Medicine, Salt Lake City, UT 84132

Donna Spannaus-Martin, PhD, MLS, University of Minnesota, Program in Clinical Laboratory Sciences, Minneapolis, MN 55455

Address for Correspondence: Karen Karni, PhD, CLS(NCA), Professor Emeritus, University of Minnesota, Program in Clinical Laboratory Sciences, Mayo Mail Code 711, 420 Delaware St. SE, Minneapolis, MN 55455

Since 1990, the American Society for Clinical Laboratory Science (ASCLS) has published a Directory of Graduate Programs for Clinical Laboratory Practitioners to aid potential students in choosing an advanced program of study at the Master's or doctoral levels in CLS or its specialty areas. The fifth edition of the Directory was published in November 2007. With a seventeen-year record of chronicling the initiation and closing of programs, the authors looked at trends in numbers of programs, their requirements, and graduates.

Li, et al., have evaluated career data and the perceived value of advanced CLS degrees.[1, 2] They surveyed M.S. and B.S. graduates and concluded that M.S. degree respondents had more managerial level positions (62% to 36% as compared to B.S. graduates) and had authored more external publications (77% to 33%). CLS M.S. professionals also perceived a greater career enhancement value to their advanced degree. Each group (B.S. and M.S.) stated the most important perceived benefit of having a CLS M.S. degree as "enhanced self-esteem and confidence." The highest priority of M.S. degree recipients' motivation for obtaining a CLS advanced degree was personal satisfaction. Fenn and Knight looked at the value of graduate education (Master's level) in clinical laboratory science among M.S. graduates from the University of Utah between 1969 and 1994.[3] They concluded that among these graduates, who had completed a program requiring research and a thesis, the "major benefits of a graduate education are the skills gained that relate to communication through writing, ability to read and interpret scientific literature, acquisition of new technical skills, and improvement of one's ability to establish successful new technologies in the laboratory."

Unfortunately, little is known about those who have graduated with doctoral degrees in clinical laboratory science, primarily because the numbers of programs and graduates are small. There were only two doctoral programs in clinical laboratory science identified in 1990, and five Ph.D. programs in 2007.

METHOD
The authors compared the advanced programs (M.S. and Ph.D.) and numbers of graduates using the first (1990) and fifth (2007) editions of the Directory. Each program's entry for the Directory has information that can be seen in Figure 1. In addition, graduates' information was gathered from the directors of two M.S. programs regarding the graduates' first positions taken following completion of their graduate degrees. These institutions have kept detailed records of their graduates' first employment positions. Types and locations of employment were collected for these graduates.

Graduate Directory Information

- Name of the School and Department
- Degree Title
- Level of Degree Awarded
- Program of Study, including areas of concentration
- Year Program was Established
- Numbers of Credits Required for Graduation (semester or quarter)
- Research Required?
- Thesis Required?
- Other Requirements, e.g., seminars, projects, papers
- Minimum GPA Considered for Admission (A=4.0)
- GRE required? Minimum Score Considered.
- If English is not the primary language, minimum TOEFL required.
- Other Prerequisites for Admission
- Enrollment Dates
- Application Deadline
- Usual Time for a Full-time Student to Complete the Degree
- Usual Time for a Part-time Student to Complete the Degree
- Tuition and Miscellaneous Fees
- Availability of Financial Aid – Full-time and Part-time Students
- Usual Number of: Full-time Students, Part-time Students, Graduates/year
- Research Facilities Available
- Location of School/Features of the Community
- Faculty Names, Degrees and Their Research Interests
- Strengths of the Program
- Recent Thesis Titles (Examples)
- Correspondence: to whom directed (Name, address, phone, fax, email)

Figure 1. Information on Each Program Listed in the Graduate Directory

RESULTS
In clinical laboratory science, there were 39 Master's programs and two doctoral programs operating in 1990. In 2007, there were 28 Master's programs and five

doctoral programs. Table 1 shows the 15 master's level programs and numbers of graduates reported in both the 1990 and 2007 editions of the Directory. Table 2 provides information on the 13 of 15 Master's level programs that were started after 1990 with the number of graduates reported in 2007. Table 3 indicates the five doctoral level programs in 2007 with numbers of graduates. Table 4 shows the 19 M.S. programs that have been discontinued since 1990. Tables 5 and 6 are an overview of graduate program requirements for admission to CLS M.S. and Ph.D. degree programs. Table 7 provides information about graduates from two recognized programs, at the University of Minnesota and the University of Utah, regarding the type and location of employment obtained following graduation.

Table 1. Institutions with Master's Programs in 1990 and 2007

	Usual Number of Graduates/Year	
Name of Institution	1990	2007
Andrews University (MI)	1-2	1-2
Indiana University – Indianapolis (IN)	3	2
Medical College of Georgia (GA)	0-1	0-2
Michigan State University (MI) CLS	3-6	6
Biomedical Laboratory Option	-	2
Quinnipiac University (CT)	19	24
Rosalind Franklin/Finch University (IL)	5	2-5
San Francisco State University (CA)	10-12	7
University of Maryland – Baltimore (MD)	2-3	5
University of Massachusetts – Lowell (MA)	3	5-10
University of Minnesota (MN)	5	4
University of North Dakota (ND)	2-4	12
University of Southern Mississippi (MS)	1	1-3
University of Utah (UT)	5	5
University of Wisconsin – Milwaukee (WI)	1-2	3-4
Virginia Commonwealth University (VA)	2-4	3-5
Range for Total Number of Students	62-75	82-98
Mean Number of Students	4-5	4-5
Median Number of Students	4	4

Total Number of Institutions: 15

Note: Only 15 of 39 institutions identified in 1990 reported offering programs in 2007.

DISCUSSION

The number of clinical laboratory science Master's level programs has decreased over a 17-year period, from 39 in 1990 to 28 in 2007. Over the same time period, the number of doctoral programs increased only slightly from two to five. The total numbers of graduates from

both levels of advanced programs are relatively small, averaging four to five M.S. graduates per program per

Table 2. New Master's Level Programs Identified Between 1990 and 2007

		Graduates
Name and State	Year Started	in 2007
Fairleigh Dickinson University (NJ)	2002	1
Long Island University	Not	20-25
C.W. Post Campus (NY)	reported	
Louisiana State University (LA)	1980	1-3
Rush University (IL) (2 programs)	2000	17
Thomas Jefferson University (PA)	2000	15
University of Alabama (AL)	1993	8
University of Kentucky (Lexington, KY)		
Reproductive laboratory science	2002	5
University of Medicine and Dentistry of NJ	1998	3-5
(NJ) (2 programs)	2002	3-5
University of Mississippi Medical Center (MS)	1996	5
University of New Mexico (NM)	2007	-
University of Rhode Island (RI)	1986	10
University of Tennessee (TN)	1999	1-2
University of Texas – San Antonia (TX)	1997	1-2
Number of Institutions added after 1990 (13 responding)		*15
Range for Total Number of Graduates after 1990		90-103
Mean Number of Graduates		8
Median Number of Graduates		4-5
TOTAL – ALL Master's Level Programs in 2007		28
TOTAL Number of Graduates in 2007		172-201
Mean Number of Graduates in 2007		6-7
Median Number of Graduates in 2007		5

Table 3. Doctoral Program - 2007

		Number of
Institution	Location	Graduates in 2007
Catholic University	Washington, DC	Not reported
Indiana University	Indianapolis, IN	1
University of Kentucky	Lexington, KY	0-1
University of Mississippi	Jackson, MS	5
Virginia Commonwealth University	Richmond, VA	2-4

Total Number of Graduates   8-11

year in both 1990 and 2007. The total numbers of doctoral graduates in 2007 were 11 or fewer.

It appears that not many laboratory science practitioners are pursuing advanced degrees within the profession. While some may be enrolled in other kinds of advanced level programs (MBA, education, public health, the basic or clinical sciences) or in other professional programs such as medicine, dentistry, pharmacy or law, the numbers staying within clinical laboratory science and earning the M.S. or doctoral degree remain modest. This is a matter of concern. Li et al.[1,2] have stated that M.S. graduates, in contrast to B.S. graduates, hold career enhancement as the major value in holding an advanced degree. Career enhancement, however, may not be sufficient to attract practitioners to pursue and complete an advanced degree in clinical laboratory science. Therefore, graduates of CLS master's or doctoral programs need to be surveyed concerning their impressions of the degrees for which they were enrolled and graduated. Baccalaureate CLS graduates who choose other kinds of advanced degrees need to be surveyed as well.

Table 4. Master's Level CLS Programs That Have Closed Since 1990.

Name	State
Brigham Young University	Utah
Eastern Washington University	Washington
Emory University	Georgia
Florida International University	Florida
George Washington University	Washington, DC
Georgia State University	Georgia
Medical University of South Carolina	South Carolina
Northeastern University	Massachusetts
Old Dominion University	Virginia
Oregon Health Sciences University	Oregon
St. John's University	New York
University of Illinois	Illinois
University of New York – Buffalo	New York
University of New York – Syracuse	New York
University of Vermont	Vermont
University of Wisconsin – Eau Claire	Wisconsin
Wayne State University	Michigan
West Virginia University	West Virginia
Wichita State University	Kansas
Number of Institutions Closed	**19**

Note: Four programs that were identified in 1990 did not respond to information for the 2007 Directory: Stanford University, the University of Alberta, Edmonton, Canada, Inter American University of Puerto Rico, San Juan, and University of Puerto Rico, San Juan.

In contrast, ASCLS (ASMT at that time) and Central Michigan University co-sponsored a Master's level external degree program in either administration or

Table 5. Overview of Master's Level Graduate Program Requirements in CLS - 2007

Category	Requirement	No. of Programs
Minimum grade point average	3.2	1
	3.0	18
	2.8	1
	2.75	4
	2.7	2
	2.5	3
Graduate Record Examination Required	Yes	17
	No	8
	International only	1
	Recommended	1
TOEFL Required	Yes	24
	No	2
	NR	2
Semester Credits Required for Graduation (not entry level)	51	1
	39	1
	37	2
	36	9
	33	3
	32	2
	31	1
	30	7
	27	1
	23	1
Thesis Required	Yes	11
	No	10
	Optional	7
Time for Completion (full time)	1 calendar year	1
	2 years	19
	2.5 years	1
	2-3 years	1
	2-6 years	1
	18 months	1
	15-18 months	2
	3 semesters	1
	3-6 semesters	1
	NR	1

From the Directory of Graduate Programs for Clinical Laboratory Practitioners, 5th Edition. Bethesda, MD; American Society for Clinical laboratory Science, November 2007. The notation NR indicates no response or unable to interpret. Data does not include two programs that did not respond to the survey.

education from 1973 to 1979.[4] During that time, 2,000 allied health practitioners were enrolled, with the vast majority being laboratorians. Their reasons for pursuing the M.S. degree were: 1) personal satisfaction; 2) an impetus for greater job security, increased income and new responsibilities; and 3) an increase in job-related skills. For graduates of the ASMT-CMU program, the most important benefit was increased personal confidence.

Table 6. Doctoral Program Requirements in CLS – 2007

Minimum grade point average	3.3	1
	2.75 – 3.0	1
	3.0	3
Graduate Record Exam required	Yes	5
TOEFL required	Yes (4)	
	NR (1)	625
	1	
	600*(250)	2
	550*(213)	1
Thesis required?	Yes	4
	Dissertation or 3 published articles	1
Usual time for completion (full time)	4-5 years	1
	4 years	3
	2-6 years	1

* = computer version

Note, however, the ASMT-CMU Master's degrees were in education or administration. The institutions surveyed in the five iterations of the <u>Directory</u> offer degrees that are primarily clinical laboratory science and research oriented. Comparisons suggest that, at least in the mid-1970s, practitioners: 1) were more interested in administration or education degrees; 2) preferred the courses in a non-traditional delivery model; and 3) perhaps had more opportunities in these areas. Today it is unknown whether and how many current laboratory practitioners are enrolled in education or administration programs and whether in traditional or non-traditional settings. Again, additional research is needed.

Francis, et al.[5] studied career progress among baccalaureate graduates from the medical technology (clinical laboratory sciences) program of the University of Minnesota. Their paper stated "those who achieved advanced degrees were 1.52 times more likely to have progressed in their career when compared with those who had no advanced degrees." Thus, there are considerable data to suggest that completion of an advanced degree is beneficial in terms of personal satisfaction, confidence and self-esteem, as well as in career advancement.

That 19 M.S. programs closed since 1990 is alarming. The decrease may parallel the decrease in the number of CLS baccalaureate programs during the same time period (from 420 to 224).[6] Nonetheless, 19 schools, with fine reputations, are no longer offering students the opportunity to gain a master's degree in the profession.

While the organizers of the Graduate Directory did not collect information regarding graduate program viability, later inquiries to administrators of closed programs did provide anecdotal information regarding the reasons for closure. Reasons included lack of institutional financial support, increased tuition, lack of resources to recruit potential students, and fewer faculty to mentor students. The decline in degree programs is also described by recent studies by Waller et al. (7). Surveying faculty in 2008, the findings in this work showed that 53% of CLS faculty had taught for 16 or more years and that 25% of the faculty were 60 years old or older, close to considering retirement from faculty status. Such turnover of faculty will impact both undergraduate and graduate level programs, and will likely be compounded by the lack of replacement faculty because of the low number of students in advanced degree programs, notably doctoral degree programs in laboratory science.

The Waller study indicated that programs average only 4.2 faculty per undergraduate program. Another study conducted in 2007 to 2008, by the Association of Schools of Allied Health Professions, provides similar information for 87 institutitions showing an average of 4.1 faculty for each CLS program.[8] Comparatively, Physical Therapy programs averaged 10.1 faculty, Speech Pathology and Audiology averaged 10.2 faculty, and Occupational Therapy averaged 7.2 faculty; all at the advanced degree level. These data do suggest that programs with a higher number of faculty can be better sustained.

Table 7A. University of Minnesota Master's Program in Clinical Laboratory Science. M.S. Graduates, Positions Taken Following Graduation & State of First Employment

Student Number	Graduation Year	First Position Following Graduation	State
1	2006	Research Fellow, Univ of Minnesota	MN
2	2006	Unknown, Boston	MA
3	2006	Asst. Scientist, Univ of Minnesota	MN
4	2006	Asst. Scientist, Univ of Minnesota	MN
5	2006	Asst. Scientist, Univ of Minnesota	MN
6	2005	CLS, Univ of Minnesota Med Ctr, Fairview	MN
7	2005	Agricultural Specialist, Board of Animal Health	
8	2005	CLS, Fairview – Collaborative Studies	MN
9	2004	Med Tech Program student, Univ of Minnesota	MN
10	2004	Res. Scientist, Mpls Med Res Fndn, HCMC	MN
11	2004	Res. Assistant, Univ of Minnesota	MN
12	2004	Sr. Res. Fellow, Univ of Minnesota	MN
13	2003	Asst. Scientist, Univ of Minnesota	MN
14	2003	Res. Assoc./Lab Mgr, Univ of Michigan	MI
15	2002	Res. Assoc., Univ of Minnesota	MN
16	2002	Student, Ph.D. Program in Genetics, Univ of Minnesota	MN
17	2002	University of Kansas	KS
18	2002	Jr. Scientist, Univ of Minnesota	MN
19	2001	Scientist, Minnesota State Board of Health	MN
20	2001	Res. Assoc., Univ of Kansas Medical Center	KS
21	2001	Student, Ph.D. Prog – Ind. U. Purdue Univ @ Indianapolis	IN
22	2001	Sci., Dept. Biochem, Molec Bio & Biophysics, Univ of Minnesota	MN
23	2000	Student, Medical School, Univ of Minnesota	MN
24	2000	Unknown	N/K
25	1999	Scientist, Cancer Center, Univ of Minnesota	MN
26	1999	Scientist, Dept. of Microbiology, Univ of Minnesota	MN
27	1999	Scientist, Lab Med and Path, Univ of Minnesota	MN
28	1999	Student, Medical School, Univ of Minnesota	MN
29	1999	Student, Ph.D. Program in Biochemistry, The Ohio State Univ	OH
30	1999	Faculty Member, Div of Medical Technology, Univ of Minnesota	MN
31	1998	Student, Medical School, Univ of North Dakota	ND
32	1998	Scientist, Neuroscience Dept., Univ of Illinois	IL
33	1998	Scientist, Dept of Lab Med and Path, Univ of Minnesota	MN
34	1998	Safety Chemist, Aveda Corporation, Twin Cities	MN
35	1997	Forensic Scientist, Bureau of Criminal Apprehension, Twin Cities	MN
36	1997	Post Doctoral Fellow, Univ of Minnesota	MN
37	1997	Scientist, Allergy Dept., Univ of Minnesota	MN
38	1997	Hematology Technical Specialist, Twin Cities Clinic	MN
39	1997	Field Application Specialist, Li-Cor Corporation	NE
40	1996	Student, MBA Program, Univ of St. Thomas, St. Paul	MN
41	1996	Student, M.S. Program in Health Informatics, Univ of Minnesota	MN
42	1996	Scientist, Clontech Corp., Palo Alto, CA	CA
43	1996	Scientist, Laboratory Animal Veterinary Clinic, Univ of Minnesota	MN
44	1996	Hematology Supervisor, Lackland AFB, Texas	TX
45	1996	Biotherapeutic Spec., Alexander & Parker Corp	N/K
46	1996	Asst, Scientist, Dept. of Medicine, Univ of Minnesota	MN
47	1996	Scientist, Laboratory Animal Veterinary Clinic, Univ of Minnesota	MN
48	1995	Dentist, California	CA
49	1995	Student, Ph.D. Program in Public Health, Univ of Texas	TX
50	1995	Student, Ph.D. Program in Pathobiology, Univ of Minnesota	MN
51	1994	Instructor, Barry Univ, Miami, FL	FL
52	1994	Research Associate, Stanford Univ	CA
53	1994	Research Associate, Singapore, Malaysia	Malaysia
54	1994	Student, Ph.D. Program in Pathobiology, Univ of Minnesota	MN

35 of 54 graduates (64%) took their first position in Minnesota.
8 of 54 graduates (15%) enrolled in advanced studies, e.g., medical school, a Ph.D. program.

Table 7B. University of Utah Master's Program in Laboratory Medicine and Biomedical Science. M.S. Graduates, Positions Taken Following Graduation & State of First Employment

Student Number	Graduation Year	First Position Following Graduation	State
1	2007	Assistant Professor, Clin Lab Sci Program	UT
2	2007	Research Scientist, University of Utah	UT
3	2007	Medical School	UT
4	2007	Teaching Specialist, ARUP	UT
5	2007	Research and Development, ARUP	UT
6	2007	Physician's Assistant Program	NV
7	2006	Research Scientist, Biotechnology Company	UT
8	2006	Research Scientist, Biotechnology Company	UT
9	2006	Medical School	UT
10	2005	Immunology Supervisor, ARUP	UT
11	2005	Research and Development, ARUP	UT
12	2005	Research and Development, ARUP	UT
13	2005	Research and Development, ARUP	UT
14	2005	Research and Development, ARUP	UT
15	2005	Immunology Supervisor, ARUP	UT
16	2004	Supervisor, biotechnology Company	UT
17	2003	High School Science Teacher – Gifted Program	UT
18	2003	MBA Program and Scientist, Res. Lab	UT
19	2003	Research Scientist, ARUP Laboratories	UT
20	2002	Medical School	VT
21	2002	Research Scientist	TN
22	2002	Research Scientist, ARUP Laboratories	UT
23	2002	Biotechnologist and Supervisor, Myriad Genetics	UT
24	2001	Dental School	UT
25	2001	Scientist, Heart Transplant Lab, U of Utah	UT
26	2001	Instructor – Weber State University	UT
27	2000	Staff Technologist, Utah Valley Hosp. blood Bank	UT
28	2000	Ph.D. Program in Cell Bio & Immunol	UT
29	2000	Biotechnologist, Myriad Genetics	UT
30	1999	Staff Technologist, Microbiology Lab – ARUP	UT
31	1999	Research Scientist, University of UT	UT
32	1999	Supervisor in Microbiology, St. Marks Hospital	UT
33	1999	Research Scientist University of Utah	UT
34	1999	Research Scientist University of Utah	UT
35	1999	Unknown	N/K
36	1998	R & D Technologist, Stem Cell lab, U of UT	UT
37	1998	Graduate School, MBA Program, U of UT	UT
38	1998	Supervisor, Reagents Lab – ARUP	UT
39	1997	Group Manager Stat Lab – ARUP	UT
40	1997	Research Scientist, University of Utah	UT
41	1997	Supervisor, Special Chemistry – ARUP	UT
42	1996	Lab Manager, U.S. Army	N/K
43	1996	Research Scientist, University of Utah	UT
44	1996	Scientist, USAF Research Lab	MS
45	1996	Supervisor/Micro Research Scientist Primary Children's Medical Center	UT
46	1996	Ph.D. Program, Canada	CAN
47	1996	Staff Technologist, Immunoheme Lab – ARUP	UT
48	1996	Research Scientist, Immunoheme Lab, VAMC	UT
49	1996	Supervisor, VAMC, Blood Bank	UT
50	1995	Unknown	N/K
51	1995	Research Technologist, Univ of Utah	UT
52	1994	Technical Supervisor – ARUP	UT
53	1994	Unknown	N/K
54	1994	Research Scientist, University of Utah	UT
55	1994	Research Scientist, University of Utah	UT

46 of 55 graduates (84%) took their first position in Utah.

7 of 55 graduates (13%) enrolled in advanced studies, e.g., medical school, dental school, a Ph.D. program.

During the same time frame (1990-2007), 13 additional M.S. programs, also from highly reputed colleges and universities, have been initiated. These schools, and their administrators, have recognized the need for and value of the M.S. degree in the profession and their states. Nonetheless, the average number of new Master's programs is less than one per year.

From Table 5, one notes that entrance to an M.S. program requires a grade point average of 3.0, with the Graduate Record Examination required by the majority of all programs. For international students, a TOEFL exam is also required. Within M.S. programs, a thesis is required by 11 of the schools (39%), and is optional at another 7 institutions.

Those considering new program implementation or curriculum revision, may find existing program criteria to be helpful. At the M.S. level, the predominant numbers are 30 and 36 for semester credits required for graduation, and the minimum TOEFL required is 550.

Finally, time for completion of these advanced programs is comparable to other M.S. or Ph.D. programs nationwide. For the M.S. degree, full-time graduate work averages two years, and for the Ph.D. degree, four years.

Along with the data provided in Tables 1 through 6, we looked at trends from the schools responding in 2007. For example, at least five institutions now offer post baccalaureate certificate programs—California State University, Dominguez Hills; University of Kentucky; University of Massachusetts – Lowell; University of Medicine and Dentistry of New Jersey; and the University of North Dakota, e.g., with majors in medical technology, cytology, reproductive laboratory science. Six institutions have entry-level master's degree programs, including the University of Alabama, Medical College of Georgia, Rosalind Franklin University of Medicine and Science (formerly Finch University), Rush University, University of Southern Mississippi, and Thomas Jefferson University. Twelve colleges/universities have online courses, and one of these, the University of Medicine and Dentistry of New Jersey has all of its courses Web-based.

The advent of these new programs and the introduction of online courses have created programs with a different focus from traditional programs. Will Master's programs, with a research focus, remain viable? Will CLS Master's and Doctoral programs graduate sufficient numbers of individuals to fill faculty positions certain to become available in the future?

This study uses information provided from the programs described in the first and fifth editions of the Directory. We also sought to ascertain, independently, what first positions and their locations that graduates of master's level programs accepted following graduation. Two programs were able to supply this kind of data. Information about graduates from the two programs are collected in Table 7A and Table 7B. Note, both of these programs are located in public universities, are science-based, requiring research, a thesis, and its defense.

It is apparent that the majority of M.S. graduates of the University of Minnesota and University of Utah take first positions
- in research arenas as scientists or specialists in universities or in industry;
- as students in advanced programs – M.D. or Ph.D.; or
- as supervisors/administrators in clinical laboratories, including the military.

Perhaps those considering implementation of advanced programs may wish to use the data from Tables 7-A and 7-B. Obviously, graduates from the University of Minnesota and the University of Utah have been successful in their first positions. Administrators and graduate school committees, might also be impressed with the impact that these graduates have had on their employers and on the geographical region in which they are employed. Research by graduates has contributed to the intellectual acumen of the sponsoring institutions and to the profession.

CONCLUSION
Is the glass half-full or half-empty? The findings that new kinds of programs are being started at varying levels, that online courses are being developed, and that graduates of existing programs are successful all support the conclusion that the glass is half-full. There are

concerns, however. The total number of Master's programs has decreased. There are relatively few numbers of graduates in many programs and the ranks of laboratory scientist faculty are aging. It behooves the profession, and faculty and administrators in colleges and universities to consider the implementation of additional CLS advanced programs, not only to better serve potential students and to advance the profession, but also to contribute to the viability of the region in which they reside.

REFERENCES

1. Li RC, Bigler WN, Blackwood LL, Venable C, Fenn JP, et al. CLS advanced degrees and career enhancement. Part 1 – Comparison of career data. Clin Lab Sci, 1998; 11 (1) 21-7.
2. Li RC, et al. CLS advanced degrees and career enhancement. Part 2 – A comparison of perceptions. Clin Lab Sci. 1998; 11 (1) 28-34.
3. Fenn JP, Knight JA. The value of graduate education in clinical laboratory science. Lab Medicine, 1995: 26 (8), 537-41.
4. Karni, K. ASMT/CMU External degree program: An evaluation summary. Am J Med Tech, 1978, 44 (9) 913-20.
5. Francis DP, Hofherr LK, Peddecord KM, Karni KR, Krolak JM. The influence of perceived professional status on the career progression of CLS graduates. Clin Lab Sci, 2001: 14 (3) 160-6.
6. National Accrediting Agency for Clinical Laboratory Science Data on program numbers (5600 N. River Road, Suite 720, Rosemont, IL 60018-5119).
7. Waller, K., Karni, K. Research and scholarship of clinical laboratory science faculty members. In press, Clin Lab Sci, 2010.
8. Institutional Profile Survey 2007-2008. Association of Schools of Allied Health Professions, 4400 Jenifer Street, NW, Suite 333, Washington, DC 20015.