RESEARCH

CLS Competencies Expected at Entry-Level and Beyond

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OBJECTIVE: The study was undertaken to assess educators', practitioners', and managers' perceptions of the future job expectations of clinical laboratory scientists (CLSs) and their opinions on the skills that are expected of CLSs at entry-level and with experience.

DESIGN: Survey participants were given a list of 44 competencies related to clinical laboratory science (CLS) practice and were asked whether they would expect a graduate of a respected CLS program to perform each competency in one of three educational categories: the first year of practice, with three to five years of experience but no additional education, or with three to five years of experience plus additional education. The competencies were subclassified into one of four major management functions: laboratory operations, human resource management, financial operations, or communications/consultation. Surveys also included eight Lickert-type questions designed to assess the respondents' opinions on the future job expectations of CLS practitioners.

PARTICIPANTS: The sample for the survey included 280 directors of CLS educational programs, 600 managers randomly selected from the Clinical Laboratory Management Association (CLMA) membership, and 600 practitioners randomly selected from the American Society for Clinical Laboratory Science (ASCLS) membership.

MAIN OUTCOME MEASURES: The percent of respondents selecting each educational category was tabulated and each competency was assigned to one educational category based on the highest percent of respondents selecting that category. The means of the responses to the Lickert-type questions were calculated for all respondents and for each group of respondents (educators, managers, and practitioners).

RESULTS: Response rates of 58% (educators), 28% (practitioners), and 39% (managers) were obtained. Of the 44 competencies in the survey, four were expected at career-entry, 17 were expected of CLS graduates with work experience but no additional education, and 23 were expected of CLS graduates with experience plus additional education. Competencies expected in the first year of practice were primarily scientific and technical. With three to five years of practice and no additional education, the expectations for practitioners were primarily in laboratory operations and communications/consultation areas. The majority of the human resource management and financial operations competencies were expected with three to five years of practice and additional education. All participants agreed that CLS staff-level practitioners need more management and administrative skills and that, in the future, CLS practitioners will spend less time performing laboratory tests and more time solving problems. CLS managers were more positive than CLS educators in response to statements asserting that CLT practitioners and non-certified personnel will have an increased role in the laboratory in the future.

CONCLUSION: This study suggests that extensive laboratory operations and communication skills are expected of CLS graduates without any additional education beyond their CLS programs. CLS educators should adequately address those areas in the curriculum. Competence in other non-technical skills may not be expected without the benefit of post-baccalaureate education and in these areas, CLS programs can provide a foundation for future learning.

ABBREVIATIONS: ASCLS = American Society for Clinical Laboratory Science; CE = continuing education; CLS = clinical laboratory science; CLSs = clinical laboratory scientists; CLT = clinical laboratory technician; MT = medical technologist; NAACLS = National Accrediting Agency for Clinical Laboratory Sciences.

INDEX TERMS: clinical laboratory science; curriculum; education; laboratory personnel; medical technologist.

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As clinical laboratory science (CLS) educators design and revise curricula, they must identify the competencies that graduates will need for professional practice. The competencies addressed in CLS curricula should include those needed for career-entry and those that will enable graduates to assume leadership roles in laboratory science, education, and management. Career-entry expectations of clinical laboratory scientists (CLSs) have been well documented in the National Credentialing Agency for Laboratory Personnel (NCA) Job Analysis studies.[1,2] These national surveys of educators, practitioners, and employers identified the competencies that are important in the first year of practice. In both the 1993–94 and 1998–99 job analyses, the majority of competencies expected of CLSs at entry-level were in scientific and technical areas. These scientific and technical skills ranged from very simple competencies such as routine urinalysis to highly complex techniques such as molecular methods for identifying microorganisms.

The competencies needed for CLS practitioners beyond entry-level are not as well defined. It is clear that the expectations and responsibilities of CLSs increase with work experience. A recent study of the job responsibilities of laboratory professionals found that after five years of practice, CLSs were performing more advanced technical skills and more management tasks. [3] Gardner and Estry studied CLS practitioners over the ten year period between 1983 and 1993 and found that job responsibilities shifted toward higher-level technical activities and management activities such as marketing services, budget control, quality assurance, and documentation.[4] Evidence of increasing job responsibilities for laboratory professionals after career-entry also comes from the NCA job analyses. The surveys used in the 1998-99 NCA job analysis contained over 80 tasks in the area of management, safety, quality assurance, and consultation. Respondents indicated that most of these tasks were not performed by entry-level CLS practitioners; however, they were being performed in their laboratories. It is likely that laboratory professionals with more experience and possibly more education are performing these higher-level tasks.[2]

Because entry-level CLSs are expected to have extensive technical skills, CLS educators devote most of their curricula to the principles, performance, and interpretation of laboratory testing. To meet accreditation standards and to prepare students for future job responsibilities, CLS educators have also included management and education competencies in the curriculum. However, the amount of time devoted to, and the content covered in these non-technical areas has been limited by the need to cover so many scientific and technical aspects of laboratory practice.

In 2000, the National Accrediting Agency for Clinical Laboratory Science (NAACLS) held a conference to discuss the future roles of clinical laboratory technicians (CLTs) and CLSs and to address changes in curricula needed to prepare graduates for these roles.[5] Participants at the NAACLS conference described the CLT of the future as the practitioner who will perform the majority of bench tests. The description of the future CLS practitioner included responsibility for in-depth analysis of data, esoteric testing, research and development, management, and consulting. The results of these discussions on the future of clinical laboratory practice are reflected in the recently adopted NAACLS Standards for Accredited CLS/MT programs. According to the NAACLS Standards, accredited CLS curricula should include principles of critical pathways, clinical decision making, performance improvement, and dynamics of healthcare delivery systems, human resource management, and financial management.[6]

To design curricula, CLS educators must be both practical and prophetic. They must ensure that students are prepared for their first jobs, which will most likely require scientific and technical expertise, and they must provide students with the knowledge, skills, and attitudes they will need to advance in their professional responsibilities. Because education does not stop after graduation, CLS educators can assume that some advanced knowledge will be added after baccalaureate education either through continuing education (CE) or formal coursework. Some responsibilities, however, may be expected of graduates without the benefit of any additional CE and, in these situations, practitioners will rely on their undergraduate CLS education for preparation.

This study was undertaken to provide additional information on the job expectations of CLS practitioners at entry-level and with experience in order to inform curriculum decisions. Specifically the study asked:

1. What are educators', managers', and practitioners' perceptions of the educational preparation and future job expectations of CLSs?
2. What are the implications of these perceptions for CLS curricula?
3. What skills are expected of CLSs in three educational categories: at entry level, in the first three to five years of practice with no additional education, and in the first three to five years of practice with additional education?
4. What are the curricular implications of the skills expected of CLSs in each educational category?

METHOD

This study was a component of a national study assessing laboratory practitioners', educators', and managers' views on educational preparation and job expectations of CLSs. A complete description of the method is provided in Beck and Doig, 2002.[7] With the assistance of an advisory board consisting of educators, managers, and practitioners, the authors developed a survey to assess the competencies expected of CLSs at entry-level and after work experience. A CLS was defined as someone who had obtained a baccalaureate degree, attained national certification, and used independent judgment to provide laboratory information and services.

Two hundred eighty directors of NAACLS accredited CLS programs were selected to serve as the sample of CLS educators. Six hundred managers were randomly selected from the Clinical Labo-

ratory Management Association (CLMA) mailing list and 600 practitioners were randomly selected from the American Society for Clinical Laboratory Science (ASCLS) mailing list.

Surveys included demographic questions on geographic region, work settings, annual volume of tests, primary job function, highest degree, and years of paid experience. Surveys also included eight Lickert-type questions designed to assess the respondents' opinions on the current and future job expectations of CLS practitioners (Table 1). Respondents were asked to read each statement and indicate their opinion using a scale on which 1 = strongly disagree and 5 = strongly agree. Practitioners were asked how many hours of continuing education they attended each year, whether or not continuing education was a requirement for their current job, the means they used to obtain continuing education, and whether or not they had taken graduate-level courses.

Respondents were given a list of 44 competencies related to CLS practice and were asked whether they would expect a graduate of a respected CLS program with excellent grades, good recommendations, and coursework in laboratory management, e.g., supervision, budgeting, quality management, and marketing to perform each competency in the first year of practice, with three to five years of experience but no additional education, or with three to five years of experience plus additional education, e.g., continuing education (CE) or formal courses. Respondents could also select none of these options. The list of competencies was developed using the NCA job analysis task lists, NAACLS CLS Standards, and the expertise of the advisory panel. Because previous studies had identified the scientific and technical competencies expected of CLSs, this list of competencies emphasized non-technical aspects of clinical laboratory practice.

The surveys and cover letters, including the definitions of terms, were tested in a pilot study using a sample of educators, managers, and practitioners from across the U.S. The surveys and definitions were revised based on comments from participants in the pilot study. Surveys were sent to the CLS educators, managers, and practitioners in March 2000. Surveys received within six weeks were included in the data analysis.

DATA ANALYSIS

SPSS 9.0 for Windows was used to analyze the data collected in this study. The means of the responses to the Lickert-type questions were calculated for all respondents and for each group of respondents (educators, managers, and practitioners). Participants' responses to the Lickert-type survey questions were classified using the following criteria: disagree = mean score of 2.5 or less;

Table 1. Mean responses of all respondents (ALL), educators (EDU), managers (MAN), and practitioners (PRAC) to statements on CLS educational preparation and job expectations

STATEMENT	ALL	EDU	MAN	PRAC	SIGN
1. In today's clinical laboratory, CLS/MT level staff members need more management and administration skills.	3.70	3.69	3.80	3.58	.14
2. CLS/MT practitioners of the future will spend more time solving problems and less time performing laboratory tests.	3.67	3.76	3.71	3.52	.05
3. In today's clinical laboratories, i.e., hospitals, commercial laboratories, and POLs, CLS/MT practitioners produce most of the billable test results.	3.61	3.78	3.46	3.64	.01
4. Non-certified personnel will constitute a significant proportion of the laboratory staff in the future.	2.84	2.42	3.07	2.93	.00
5. Baccalaureate-level CLS/MT programs are adequately preparing students for the future clinical laboratory environment.	3.54	3.70	3.37	3.63	.00
6. In the future, there will be a need for more CLT/MLT level practitioners and fewer CLS/MT level practitioners.	3.31	3.06	3.48	3.30	.00
7. Baccalaureate degree CLS/MT programs should focus on the sciences underlying laboratory testing, not on management and education.	3.03	3.20	2.83	3.16	.00
8. In the future, associate-degree CLT/MLT practitioners will be doing the majority of laboratory testing.	3.42	3.17	3.62	3.39	.00

Disagree = ≤2.5, Undecided = >2.5 and <3.5, Agree = ≥3.5; SIGN = significance (p <0.01)

undecided = mean score greater than 2.5 and less than 3.5; and agree = mean score of 3.5 or higher. Analysis of variance was used to assess differences in responses among groups. The level of significance was set at a p value of less than 0.01 and significant differences were analyzed using the LSD (least significant difference) and the Tukey's honestly significant difference tests.

The percent of respondents selecting each educational category (in the first year of practice, with three to five years of experience but no additional education, with three to five years of experience plus additional education, or none of these) was tabulated. Each competency was assigned to one educational category based on the highest percent of respondents selecting that category. The authors independently sub-classified the competencies in one of four major management functions: laboratory operations, human resource management, financial operations, or communications/consultation. Differences in sub-classifications were discussed and a final assignment was determined by consensus.

RESULTS

Response rate

Usable surveys were received from 163 educators (58%), 231 managers (39%), and 166 practitioners (28%) for a total of 560 (38%) respondents.

Demographic information

A complete description of the demographic information from this study is provided in Beck and Doig, 2002.[7] The respondents in each group came from all geographic regions and institutions of all sizes. The majority of managers (74.9%) and practitioners (63.1%) worked in hospitals or medical centers and most educators indicated that they worked either in a hospital/medical center (46%) or an educational program (41.1%). Eighty-eight percent of NAACLS program directors indicated that their primary job function was educator and over 95% of the CLMA members listed their job function as supervisor, administrator, or director. Most of the respondents in the practitioner survey (55.4%) listed CLS or medical technologist (MT) as their primary job function. The majority of the managers (60.2%) and practitioners (68.5%) indicated that a baccalaureate degree was their highest degree. Respondents in the educator group had the highest percent of master's degrees (54.6%) and doctorates (28.8%). The educator group was also the oldest group of respondents with 79.8% reporting that they had over 20 years of paid experience. The practitioners were younger than the educator and manager groups, with 50% of practitioners indicating that they had fewer than 20 years of experience.

Practitioners' continuing education

Over half of the practitioners (56.4%) reported that they attended 11 or more hours of CE each year. Nineteen percent of the respondents attended between six and ten hours of CE, 16.8% attended between three and five hours of CE, and 7.8% reported attending between zero and two hours of CE each year. One half of the practitioners stated that CE was a requirement for their current job.

Practitioners obtained CE in a variety of ways with external CE programs cited by the highest percent of respondents (88%). The other means of obtaining CE included in-house CE programs (83%), journal articles (69%), selected graduate level courses (25%), graduate level degree programs (21%), courses on the Internet (14%), and mail or audioconferences (2%).

Ninety (53.5%) of the practitioners indicated that they had taken graduate level courses. They described the emphasis of these courses as scientific topics (38%), management/business (31%), education/training (18%), a combination of scientific, management, and education courses (11%), and computers (2%).

Opinions on current and future CLS practice

Responses of educators, managers, and practitioners to eight questions related to CLS educational preparation and job expectations are shown in Table 1. All groups agreed that CLS staff-level practitioners need more management and administrative skills and that, in the future, CLS practitioners will spend less time performing laboratory tests and more time solving problems (statements 1 and 2). Managers were undecided while educators and practitioners agreed with the statement that CLSs produce the most billable results in today's clinical laboratory (statement 3); however, the differences in responses to statement 3 among these three groups were not significant.

Significant differences in the responses of educators and managers were detected in the analysis of statements 4, 5, 6, 7, and 8. Educators were more negative (more in disagreement) than managers when responding to statements suggesting that there will be an increased role for non-certified personnel (statement 4) and for CLT practitioners (statements 6 and 8) in the future. Educators were more positive (more in agreement) than managers in response to the statements asserting that BS programs are adequately preparing students for the future (statement 5) and that the BS programs should focus on science rather than management (statement 7).

Practitioners' responses for all eight statements were not significantly different from managers' responses. Practitioners differed from educators, however, in their responses to statement 4 which suggested that there will be more non-certified personnel in the future. Practitioners' responses were more positive (more in agreement) than educators in response to this statement.

Competencies expected of CLSs

In Table 2, the percent of all respondents (educators, managers, and practitioners combined) who classified a competency into each educational category is listed. Competencies are listed below in the educational category selected by the highest percent of respondents. The competencies in each educational category are further

Table 2. Percent of all respondents (n = 560) classifying competencies in educational categories

COMPETENCY	EDUCATIONAL CATEGORY (%) First year	Experience No CE	Experience with CE	None of these
1. Perform routine testing in all areas of the clinical laboratory.	94.5	4.3	0.5	0.7
2. Perform advanced testing, e.g., flow cytometry, DNA analysis.	21.4	35.3	41.5	1.8
3. Explain the basic analytical principles involved in laboratory procedures.	86.6	8.8	4.7	0
4. Resolve problems encountered in performing routine laboratory tests.	67.3	27.9	4.8	0
5. Establish protocols for acceptance or rejection of assay data based on quality control results.	51.0	32.8	16.2	0
6. Design protocols for monitoring or maintaining instruments and equipment.	22.9	48.6	26.8	1.8
7. Participate in decisions regarding laboratory instrumentation or equipment purchases.	11.1	58.0	27.3	3.6
8. Participate on laboratory and hospital committees; safety, transfusion, utilization review, etc.	13.4	61.0	23.2	2.5
9. Write or edit job descriptions.	7.7	41.9	44.7	5.7
10. Recruit and hire staff in compliance with current labor laws or regulatory standards.	3.2	20.0	67.1	9.6
11. Coach staff members to improve job performance.	5.0	41.1	48.5	5.4
12. Use principles of leadership and delegation to supervise and motivate staff.	3.2	30.1	60.5	6.3
13. Prepare staff schedules.	17.5	65.9	13.9	2.7
14. Conduct and evaluate clinical instruction and continuing education for laboratory personnel.	6.2	32.1	57.6	4.1
15. Develop and implement programs to document employee competency in the laboratory.	3.3	36.3	55.7	4.8
16. Develop programs that comply with federal regulations, e.g., CLIA, and voluntary accrediting requirements, e.g., CAP, JCAHO.	3.2	23.0	67.9	5.8
17. Interpret regulations and write procedures for safety, e.g., blood borne pathogens, chemicals, fire, and sharps.	8.7	33.2	53.7	4.5
18. Develop or revise a disaster plan.	5.3	37.3	48.8	8.6
19. Write laboratory procedures and manuals.	17.6	52.8	27.8	1.8
20. Establish guidelines for confidential handling of laboratory results and personnel information.	14.3	47.3	32.9	5.5
21. Monitor and troubleshoot daily operations of a computer system.	21.0	35.1	37.8	6.1
22. Design, implement, and evaluate QA and CQI (continuous quality improvement) procedures.	6.4	36.1	53.5	3.9
23. Assess current methods and evaluate the need to adopt new methods.	8.0	50.4	37.7	3.0
24. Coordinate proficiency testing.	18.9	60.5	19.1	1.4
25. Perform turn around time studies, i.e., from patient to laboratory to reported result.	31.0	54.2	13.5	1.2
26. Coordinate laboratory services with other departments to improve patient care.	11.8	60.5	23.6	4.1
27. Analyze laboratory and patient data to improve laboratory test utilization and services.	9.3	47.1	36.8	6.8
28. Evaluate and select capital equipment purchases including laboratory information systems.	2.0	32.3	54.2	11.6
29. Consult with other healthcare providers regarding analytical aspects of laboratory services.	13.1	44.2	35.0	7.7
30. Develop and implement test strategies, e.g., test sequencing and clinical pathways for use in practice guidelines.	3.2	34.7	48.2	13.8
31. Develop a business plan for laboratory operations.	0.4	8.6	73.5	17.5
32. Develop public relations programs for client services.	3.0	21.9	58.6	16.4
33. Market new laboratory services.	3.4	25.3	55.8	15.5
34. Develop and implement outreach programs for laboratory tests and services.	1.4	25.5	59.5	13.6
35. Prepare a laboratory or departmental budget.	2.7	26.2	61.5	9.7
36. Develop and implement a compliance plan for reimbursement and medical necessity requirements.	0.9	10.7	73.9	14.5
37. Negotiate contracts for laboratory services.	0.4	12.1	67.9	19.6
38. Evaluate patients' laboratory results and determine the need for additional tests.	32.9	33.8	21.1	12.0
39. Perform method evaluation studies to adopt new methods.	23.6	45.2	28.4	2.9
40. Monitor current test costs.	19.3	48.8	27.8	4.1
41. Evaluate the need and decide whether to outsource laboratory tests or services.	5.5	40.9	42.3	11.3
42. Consult with other healthcare providers regarding the significance and value of laboratory results.	14.2	38.9	34.9	12.0
43. Address ethical questions related to laboratory testing and services.	24.4	32.8	31.0	11.6
44. Analyze research data and apply results to current laboratory practice.	12.5	32.1	43.7	11.6

classified into one of four management functions (laboratory operations, human resource management, financial operations, and communications/consultation).

First year of practice:
Laboratory operations:
- Perform routine testing in all areas of the clinical laboratory. (94.5%)
- Explain the basic analytical principles involved in laboratory procedures. (86.6%)
- Resolve problems encountered in performing routine laboratory tests. (67.3%)
- Establish protocols for acceptance or rejection of assay data based on quality control results. (51.0%)

Three to five years of experience but no additional education:
Laboratory operations:
- Coordinate proficiency testing. (60.5%)
- Perform turn around time studies, i.e., from patient to laboratory to reported result. (54.2%)
- Write laboratory procedures and manuals. (52.8%)
- Assess current methods and evaluate the need to adopt new methods. (50.4%)
- Design protocols for monitoring/maintaining instruments and equipment. (48.6%)
- Establish guidelines for confidential handling of laboratory results and personnel information. (47.3%)
- Analyze laboratory and patient data to improve laboratory test utilization and services. (47.1%)
- Perform method evaluation studies to adopt new methods. (45.2%)
- Evaluate patients' laboratory results and determine the need for additional tests. (33.8%)
- Address ethical questions related to laboratory testing and services. (32.8%)

Human resource management:
- Prepare staff schedules. (65.9%)

Financial operations:
- Participate in decisions regarding laboratory instrumentation or equipment purchases. (58.0%)
- Monitor current test costs. (48.8%)

Communications/consultation:
- Participate on laboratory and hospital committees (safety, transfusion, utilization review, etc.). (61.0%)
- Coordinate laboratory services with other departments to improve patient care. (60.5%)
- Consult with other healthcare providers regarding analytical aspects of laboratory services. (44.2%)
- Consult with other healthcare providers regarding the significance and predictive value of laboratory results. (38.9%)

Three to five years of experience plus additional education, e.g., CE or formal courses:
Laboratory operations:
- Develop and implement a compliance plan for reimbursement and medical necessity requirements. (73.9%)
- Develop programs that comply with federal regulations, e.g., CLIA and voluntary accrediting requirements, e.g., CAP, JCAHO. (67.9%)
- Develop and implement outreach programs for laboratory tests and services. (59.5%)
- Interpret regulations and write procedures for safety, e.g., blood borne pathogens, chemicals, fire, and sharps. (53.7%)
- Design, implement, and evaluate QA and CQI (continuous quality improvement) procedures. (53.5%)
- Develop or revise a disaster plan. (48.8%)
- Develop and implement test strategies, e.g., test sequencing and clinical pathways for use in practice guidelines. (48.2%)
- Analyze research data and apply results to current laboratory practice. (43.7%)
- Perform advanced testing, e.g., flow cytometry, DNA analysis. (41.5%)
- Monitor and troubleshoot daily operations of a computer system. (37.8%)

Human resource management:
- Recruit and hire staff in compliance with current labor laws or regulatory standards. (67.1%)
- Use principles of leadership and delegation to supervise and motivate staff. (60.5%)
- Conduct and evaluate clinical instruction and continuing education for laboratory personnel. (57.6%)
- Develop and implement programs to document employee competency in the laboratory. (55.7%)
- Coach staff members to improve job performance. (48.5%)
- Write or edit job descriptions. (44.7%)

Financial operations:
- Develop a business plan for laboratory operations. (73.5%)
- Negotiate contracts for laboratory services. (67.9%)
- Prepare a laboratory or departmental budget. (61.5%)
- Evaluate and select capital equipment purchases including laboratory information systems. (54.2%)
- Evaluate the need for and decide whether to outsource laboratory tests or services. (42.3%)

Communications/consultation:
- Develop public relations programs for client services. (58.6%)
- Market new laboratory services. (55.8%)

Of the 44 competencies in the survey, four were expected at career-entry, all sub-classified in laboratory operations. Seventeen competencies were expected of CLS graduates with work experience but no additional education. Ten of these competencies were

in laboratory operations, one was in human resources, two were in financial management, and four were in the communications/consultation sub-classification. Twenty-three of the competencies on this survey were expected of CLS graduates with experience plus additional education. In this educational category, ten competencies were sub-classified as laboratory operations, six were in human resource management, five were in financial management, and two were in communications/consultation.

DISCUSSION

There was general agreement among educators, practitioners, and managers that CLSs are currently doing the majority of laboratory testing and will be doing less testing and more problem solving in the future. There were differences of opinion among the respondent groups, however, when they were asked about an increased role for CLTs and non-certified personnel. Educators had the strongest negative response to the suggestion that there will be more non-certified personnel in the laboratory of the future. Educators were also significantly more negative than managers when asked if CLTs would be performing more testing in the future. If CLSs are doing less testing, it is not clear who educators see as the major testing personnel in the future. CLS educators may be reluctant to envision a future in which CLTs or non-certified personnel replace CLS practitioners. Alternatively, CLS educators may think that changes in technology alone could result in CLSs spending less time performing laboratory tests and more time solving problems.

All groups agreed that CLSs need more management and administrative skills and that the problem solving roles of CLSs will increase in the future. These findings are consistent with the description of future CLS practitioners generated at the NAACLS conference and they validate the need for non-technical skills, such as management and administration in the CLS curriculum. It is interesting to note, however, that the educators and managers in this study differed significantly in their responses to two statements addressing how CLS programs are preparing students for their future roles. Educators agreed with the statement that CLS programs were adequately preparing students for the future while managers were undecided in response to this question. Educators also felt more strongly than managers that the CLS curriculum should emphasize the sciences underlying laboratory testing rather than management and education. The fact that managers and educators in this study differed in their views of the adequacy of the current CLS education and the appropriate content in BS curricula may be cause for concern. This highlights the need for ongoing communication between these two groups of laboratory professionals to ensure that managers understand the scope and limits of the CLS curriculum and educators understand the real job expectations of CLS practitioners.

The respondents' classification of competencies in each of three educational categories provides useful descriptions of CLS practitioners and their job responsibilities. Only a few of the competencies on the survey were classified by the respondents as expected at entry-level. This was not surprising given that the survey emphasized non-technical competencies that had been described as beyond entry-level in previous studies. All of the competencies classified as expected at career-entry were in the area of laboratory operations and included performing tests, resolving testing problems, explaining results, and using quality control data. The emphasis on the scientific and technical skills in the first year of practice is consistent with the entry-level expectations identified in NCA job analysis studies. The low number of management skills included in this educational category is also consistent with previous studies addressing management skills expected of entry-level practitioners.[8]

Competencies classified in the second educational category, expected within three to five years of practice without additional CE or coursework, included those sub-classified in the laboratory operations, human resource management, financial operations, and communications/consultation areas. Laboratory operations competencies went beyond performing tests to encompass an understanding of the total testing process. They included proficiency testing, turn around time studies, writing procedures, and method evaluation. Only one competency in human resource management, preparing staff schedules, was expected at this level. Financial management expectations were also minimal and included participating in purchasing decisions and monitoring test costs. The communications/consultations expectations of a practitioner with several years of experience, however, were significant. The practitioner was expected to effectively represent the laboratory in committees, coordinate laboratory services with other departments, and explain the analytical aspects, significance, and predictive value of laboratory tests to others. The picture that emerges of the CLS practitioner with three to five years experience is one who is competent in laboratory testing, involved in all aspects of the testing process, and able to consult with other healthcare professionals on issues related to laboratory testing.

The competencies that are classified in the third educational category, expected with three to five years of practice plus additional education, were sophisticated and broad. The laboratory operations competencies included specialized testing, e.g., flow cytometry and DNA analysis as well as competencies that required an understanding of the healthcare system and regulatory agencies that affect laboratory services. Most of the competencies in human resource management and financial management were found in this third category. Communication/consultation competencies involved articulating the laboratory's services to others outside of the individual's institution.

The respondents' classification of competencies in each of three educational categories provides a guide for CLS curriculum planning. Competencies classified in the first and second educational categories represent the knowledge, skills, or attitudes that must

be addressed in the CLS curriculum because they will not necessarily be addressed by additional education after graduation. The emphasis on technical skills in the first year of practice and the emphasis on communication skills in three to five years of practice without additional education underscore the importance of the scientific and technical content in the CLS curriculum. Laboratory practitioners will rely on their undergraduate education to prepare them for performing all aspects of laboratory testing and for explaining that information and the role of the laboratory to others. The competencies that are classified in the third educational category, expected with three to five years of practice plus additional education, do not need to be completely addressed in the CLS curriculum, although the CLS curriculum should lay a foundation for future education in these areas.

The results of this study can be used by educators in conjunction with the NAACLS Standards to make decisions about curriculum content. The NAACLS Standards are intended to provide broad guidelines for CLS curricula. The results of this study provide more specific descriptions of the competencies that should be included in the CLS curriculum. For example, the recently adopted NAACLS Standards describe the entry-level CLS as one who has basic knowledge in "communications to enable consultative interactions with members of the healthcare team, external relations, customer service and patient education". CLS curricula are required to include "principles of interpersonal and interdisciplinary communication and team-building skills".[6] This study included descriptions of six competencies related to communication and consultations, most of which were categorized as competencies expected of graduates within three to five years of practice without additional education. This provides educators with more concrete information about the communication/consultation skills needed and confirms the importance of addressing these skills in the CLS curriculum.

Educators can also use the results of this study to make decisions about the amount of emphasis needed in a particular area. For example, the proposed NAACLS Standards state that the CLS curriculum should include concepts and principles of "human resource management to include position description, performance evaluation, utilization of personnel, and analysis of workflow and staffing patterns".[6] In this study, only one out of seven human resource management competencies, preparing staff schedules, was expected without additional education. The CLS curriculum should, therefore, give students the skills they need to prepare staff schedules; however, for other human resource management competencies, only a foundation for future learning is needed.

The results of this study emphasize the importance of both the BS curriculum and CE in the professional development of CLSs. The 21 competencies included in the first two educational categories must be addressed in the BS curriculum and the 23 competencies that were in the third educational category (experience plus additional education) provide an outline for continuing education programs or for a master's degree curriculum. The number of CLSs who are regularly participating in CE activities indicates that practitioners need additional education to maintain competence and advance in their jobs. Most practitioners were obtaining CE through traditional external and internal presentations. At the time of this survey, Internet courses were not used extensively; however, that may change in the future and be reflected in studies of this type.

LIMITATIONS

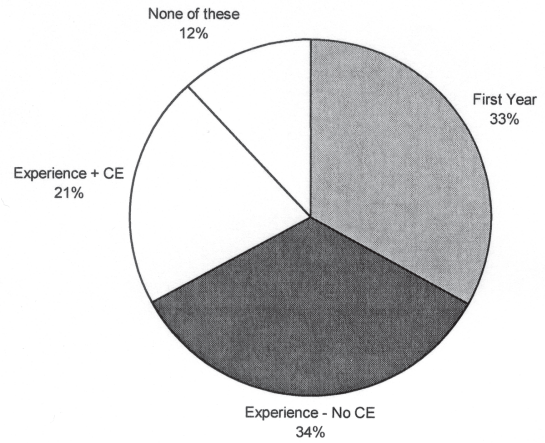
This survey was limited by the date of sampling and by length. The survey reflects the views of educators, practitioners, and managers at one point in time. It should be repeated in three to five years to detect changes in opinions and expectations. The comprehensiveness of the survey was limited by the need to keep the length of the survey reasonable. The response rates for this survey were considered good for a national, unsolicited survey indicating that the survey length was not overwhelming.

It must be noted that the classification of competencies into educational categories was based on the percent of respondents selecting a category and, in some cases, the responses were split across several categories making the classification less definite. The first competency on the survey is a good example of a clear-cut result. Approximately 95% of the respondents classified "perform routine testing in all areas of the clinical laboratory", as expected in the first year of practice. A competency that is less clearly classified is illustrated in Figure 1. Competency number 38, "Evaluate patient's laboratory results and determine the need for additional tests", was classified as expected in the first three to five years of practice based on the views of 34% of the respondents. However, 33% of the respondents felt that this competency could be expected in the first year of practice and 21% indicated it would be expected after obtaining experience and CE. In cases in which the responses were split between several categories, educators can use the percentages in all categories to decide how much emphasis the competency should receive in the curriculum. For the example in Figure 1, most respondents placed this competency in an educational category that relied on the BS curriculum for preparation (either first year of practice or with experience but no CE). Educators therefore would want to address this competency in the CLS curriculum.

SUMMARY

The results of this study shed light on the current discussions concerning the appropriate curriculum for CLS programs. While there is general agreement that CLS programs must adapt to meet the needs of the future, and that adaptation includes adding more non-technical skills, it is not clear what those skills are. This study suggests that laboratory operations skills that require an understanding of the total testing process and communication skills are expected of CLS graduates without any additional education beyond their CLS programs. CLS educators should adequately address those areas in the curriculum. Competence in other non-

Figure 1. Respondents' classification of the competency "Evaluate patients' laboratory results and determine the need for additional testing"



technical skills may not be expected without the benefit of post-baccalaureate education and in these areas, CLS programs can provide a foundation for future learning. This study highlights the importance of entry-level education in CLS programs and the need for on-going professional education after graduation.

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REFERENCES

1. Beck SJ, Doig K, Nettles SS. CLT and CLS job responsibilities: definitions and distinctions. Clin Lab Sci 1997;10(1):19-26.
2. Doig K, Beck SJ, Kolenc K. CLT and CLS job responsibilities: current distinctions and updates. Clin Lab Sci 2001;14(3):173-82.
3. Ward-Cook K, Tatum D, Jones G. Medical technologist core job competencies still reign. Lab Med 2000;31(7):375-9.
4. Gardner P, Estry D. Changing job responsibilities in clinical laboratory science: A report on the 1989 ASMT national personnel survey. Clin Lab Sci 1990;3(6):382-8.
5. The laboratory professional of the future. A compilation of data from the September 22, 2000 NAACLS Futures Conference. National Accrediting Agency for Clinical Laboratory Sciences. Chicago, IL. 2000.
6. Standards of Accredited Educational Programs for the Clinical Laboratory Scientist / Medical Technologist. National Accrediting Agency for Clinical Laboratory Sciences. Chicago, IL. 2001.
7. Beck SJ, Doig K. An entry-Level MS degree in CLS: Is it time? Clin Lab Sci 2002. 15(3):167-76.
8. Karni KR, Seander DG. Management skills needed by entry-level practitioners. Clin Lab Sci 1988;1(5):296-300.

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