

The State of the California Medical Laboratory Technician Workforce

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Abstract / Overview

California faces laboratory workforce shortages to meet the healthcare demands of the population. This national study compares the California MLT workforce to the rest of the country. The California MLT supply is scarce and the scope of practice laws are more restrictive than any other state. Laboratory personnel in other states that regulate MLTs generally support MLTs practicing to their highest level of training.

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Key Findings

- California has a scarce MLT supply relative to the size of the population.
- California has the most restrictive scope of practice and supervision laws regulating MLTs compared to all other states.
- Laboratory directors in other states that regulate MLTs generally perceived MLTs as beneficial to productivity and quality.
- Some concerns were raised about MLTs decision-making and troubleshooting abilities, and the variability in individual MLT skills and knowledge base.

Background

Shortages in the healthcare workforce are well known in the fields of primary care, behavioral health, long-term care, and oral health. Workforce shortages of clinical laboratory professionals may be less well known because they are often less visible to the public. However, clinical laboratory professionals are critical to health care delivery and efficiency. Overall laboratory workforce vacancy rates have increased in nearly all specialty areas of the clinical laboratory and anticipated retirement rates are higher than two years ago.¹ Laboratory workforce shortages are attributable to similar forces as in other health workforce occupations, namely an aging population, a growing chronic disease burden, and an increasing number of newly insured patients under the Patient Protection and Affordable Care Act (ACA).²⁻⁴ To address healthcare workforce shortages, the National Academy of Medicine recommends broadening the duties and responsibilities of health workers at various levels of training.⁵

California has historically employed far fewer clinical laboratory workers per population compared to other states.⁶ Medical Laboratory Technicians (MLTs) became a licensed occupation in California in 2007 after a long period of development of training curriculum and regulations for practice.⁷ Clinical Laboratory Scientists (CLSs) are Bachelor Degree trained while MLTs are Associate Degree trained laboratory professionals. In California, the complexity of a test determines which level of laboratory personnel can perform the test and under what level of supervision (Appendix 1). A survey conducted by the California Hospital Association's Healthcare Laboratory Workforce Initiative (HLWI) in 2007 showed that 63% of hospitals plan to use MLTs to address projected shortages in the CLS workforce.⁸

A 2014 study of MLT utilization in California revealed challenges to increasing the use of MLTs including opposition by incumbent workers and administration, state legislative limitations to MLT scope of practice, limited number of MLT training programs, limited clinical internship positions, and scarcity of MLT job openings.⁹ Drivers that facilitated the integration of MLTs included an aging and shrinking CLS workforce, increasing automation of laboratory testing, and the expected cost benefits of hiring more MLTs.⁹

Expanding the scope of practice for MLTs in California may provide one solution to alleviating California's ongoing shortage of clinical laboratory personnel. The HLWI identified three possible areas for expanding the MLT scope of practice in California: microscopic blood smear reviews (morphology and manual white blood cell differential), microscopic urinalysis, and immunohematologic blood typing (moderately complex ABO/Rh testing). These tests were selected by the HLWI committee after thoughtful

deliberation for three reasons: they are high volume tests that would have a measurable impact on laboratory efficiency and the current workforce shortage, they are categorized as moderately complex under CLIA, and they are performed using instrumentation that is also categorized as moderately complex.

We conducted a national study of MLTs to better understand national variability in supply; scope of practice; and impact. The study aims to:

1. Describe state-level differences in the supply of MLTs in California compared to other states that also regulate MLTs.
2. Compare the scope of practice laws regulating MLTs in California with other states that also regulate MLTs.
3. Understand how the use of MLTs, particularly with regard to the three areas identified a priori by the HLWI, might impact quality, safety, and productivity.

Methods

To address the first study objective, we examined publicly available national data to determine the supply of MLTs in each of the 50 states and Washington DC. The Bureau of Labor Statistics (BLS) Occupational Employment Statistics (OES) produces national workforce estimates that are the industry standard for comparing the US workforce across states and occupations.¹⁰ Analysis of these data revealed that MLT counts in both regulated and unregulated states were drastically inflated due to the inclusion of laboratory personnel that do not meet the criteria for a licensed MLT. In the absence of credible national data on only MLTs, we contacted individual state licensing boards for the twelve regulated states to request data on the number of licensed MLTs. Two thirds of regulated states responded to the request for information (8 of 12).

To quantify growth in the MLT supply, we obtained data from 2011-2015 from the American Society of Clinical Pathology (ASCP), which tracks certified MLTs by their mailing address. These data allowed us to describe state-level differences in the supply of new entrants into the MLT workforce.¹¹ Caution must be exercised in interpreting these data because mailing addresses may not represent the employment location, certified MLTs may not be employed as MLTs, and some states allow employment of non-certified MLTs. Finally we assessed publicly available data from the National Accrediting Agency for Clinical Laboratory Sciences to identify state-level differences in the number of MLT education programs.¹² To our knowledge, no other data sources exist to describe the number of MLTs by state.

To address the second objective, we searched state sponsored websites to obtain primary source documents of MLT legislation for the twelve states that license and regulate MLTs. Unregulated states default to national regulations. The Centers for Medicare & Medicaid Services (CMS) regulates all laboratory testing and personnel in the U.S. through the Clinical Laboratory Improvement Amendments (CLIA) of 1988.^{13,14} State regulations can be more restrictive than the federal CLIA laws, but not less. We then analyzed the content of the legislation for each state and developed a matrix to capture the discrete components of the scope of practice laws. Specifically, we documented legislation pertaining to education requirements, licensing requirements, supervision requirements, and scope of practice elements. We were interested in the level of CLIA complexity permitted and the three areas identified a priori by the HLWI: blood smear reviews, urinalysis, and blood typing. The matrix served as a basis for analyzing state-level differences in the scope of work performed by MLTs in California versus other states.

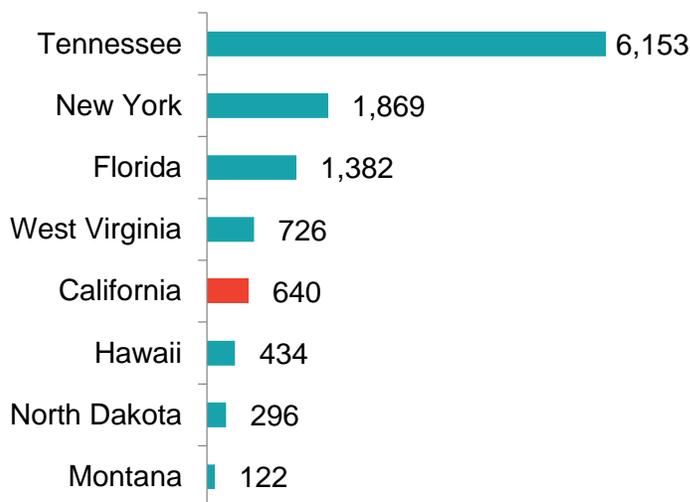
To address the third study objective, we conducted semi-structured interviews with Clinical Laboratory Scientists, Medical Laboratory Technicians, and directors of laboratory services at laboratories located in states that license and regulate MLTs. HLWI members, ASCP staff, and interviewees assisted the research team in identifying potential interviewees. We contacted 42 potential interviewees via email and/or telephone: 15 responded, and 10 agreed to be interviewed. We conducted semi-structured interviews based on an interview guide developed by the research team (Appendix 3). Thematic analysis of interview transcripts was conducted by a minimum of two research team members and three when inter-reviewer agreement was not aligned.

Supply of Licensed MLTs

For the purpose of this study we differentiate regulated states that license and regulate the practice of MLTs at the state level, and unregulated states that do not have licensure requirements or legislation to dictate MLT practice. As of 2016 the majority of states do not regulate MLT practice. The twelve states that regulated MLTs are Florida, Georgia, Hawaii, Louisiana, Montana, Nevada, New York, North Dakota, Rhode Island, Tennessee, and West Virginia. Tennessee has more licensed MLTs than any other regulated state with over 6,000. California ranks fifth with ten times fewer than Tennessee (Figure 1).

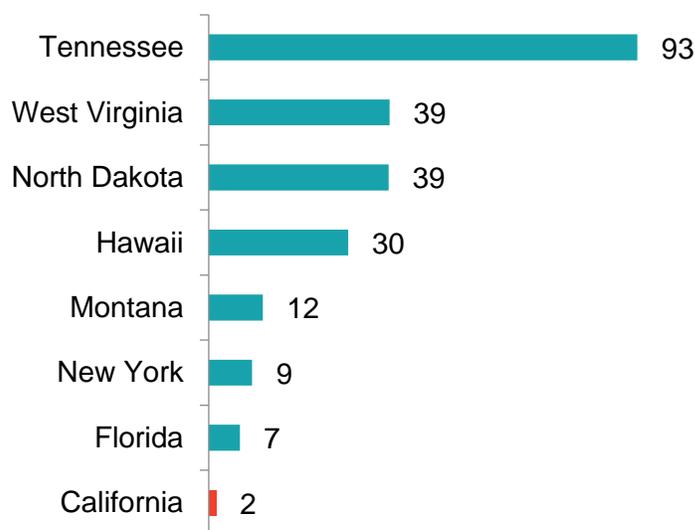
California is the most populous state with over 39 million people.¹⁵ When we compare the number of licensed MLTs relative to the size of the population of each regulated state, California drops to last place with 2 licensed MLTs per 100,000 people (Figure 2). The scarcity of MLTs relative to the population represents an opportunity to expand the MLT workforce to serve Californians.

Figure 1: Number of Licensed MLTs in Regulated States, 2016



Data Source: Individual State Licensing Boards, Proprietary data on number of licensed MLTs as of December 2016. Data unavailable for Georgia, Nevada, Rhode Island, & Louisiana.

Figure 2: Licensed MLTs per Capita* in Regulated States, 2016

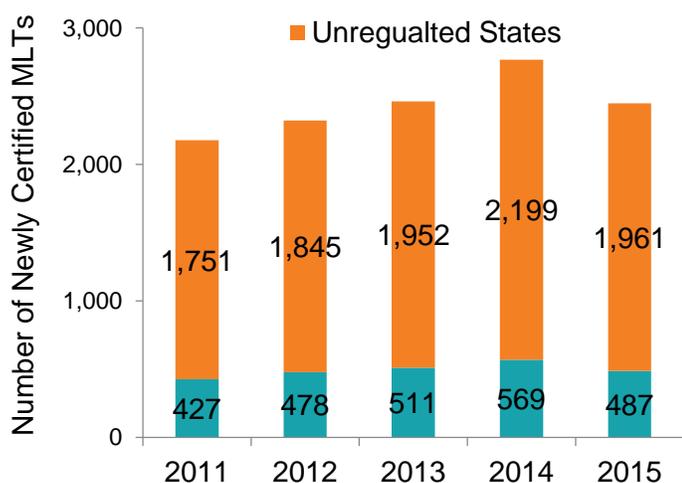


* Per 100,000 population
 Data Source: Individual State Licensing Boards, Proprietary data on number of licensed MLTs as of December 2016. Data unavailable for Georgia, Nevada, Rhode Island, & Louisiana.

To further describe growth in the supply of MLTs, we examined data on newly certified MLTs across the country in the last five years. Certified MLTs have demonstrated competency through a series of qualifications and examinations administered by a national organization such as the American Society for Clinical Pathology (ASCP), and non-certified MLTs that may be working under the title MLT without completing the requirements to be nationally certified. Not all states require national certification to practice as an MLT, which adds complexity to the task of counting and comparing MLTs by state.

MLT certification data from ASCP reveal that the number of newly certified MLTs increased every year from 2011 to 2014. Slightly fewer new MLTs were certified in 2015 compared to the previous four years. We further examined growth in the MLT occupation in regulated versus unregulated states. The rate of growth was similar in regulated and unregulated states at 55% and 53%, respectively (Figure 3).

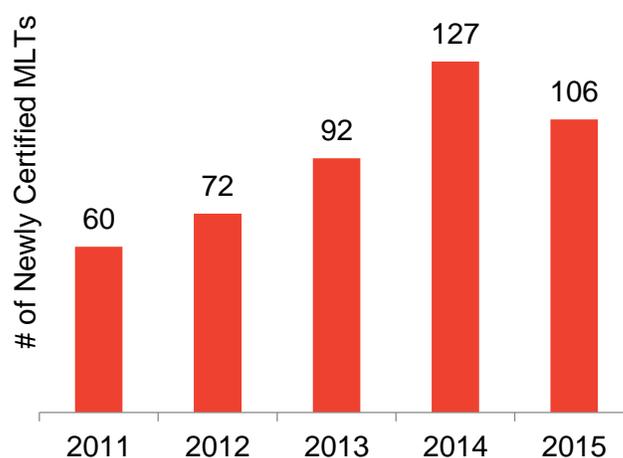
Figure 3: National Growth in Newly Certified MLTs, 2011-2015



Data Source: American Society for Clinical Pathology. Proprietary data on newly certified MLTs from 2011-2015. Includes 50 states and Washington, D.C.

The rate of growth of newly certified MLTs in California is 66% per year from 2011-2015, a faster rate of growth than the national rate of 54% over the same time period. In 2011, sixty new MLTs were certified in California. The number increased every year through 2014 to a peak of 127 newly certified MLTs with a slight drop to 106 in 2015 (Figure 4).

Figure 4: Growth in Newly Certified MLTs in California, 2011-2015



Data Source: American Society for Clinical Pathology. Proprietary data on newly certified MLTs from 2011-2015.

While the rate of growth is promising, the total number of new MLTs per year is small. One reason for the relatively low number of newly certified MLTs in California may be the narrow educational pipeline. California has four accredited MLT training programs to supply MLTs for the entire state.¹² Further investigation is needed to determine the percentage of California MLTs that train within California.

On average, newly certified MLTs in California earn a higher wage, are younger, and less likely to be female compared to the national average (Figures 5a-c, Appendix 2a & 2c). The incoming MLT

workforce is young relative to the CLS workforce and less prone to attrition due to retirement.

Figure 5a: Mean Wage

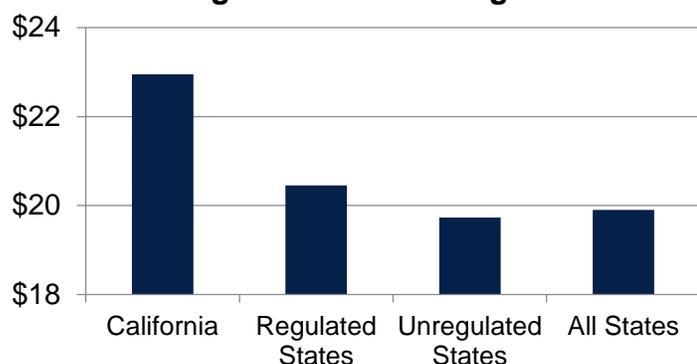


Figure 5b: Mean Age

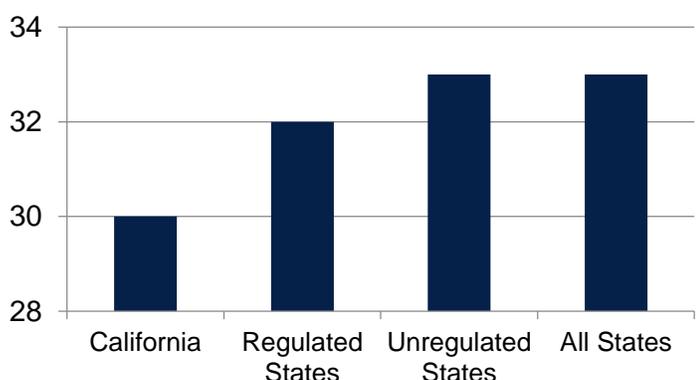
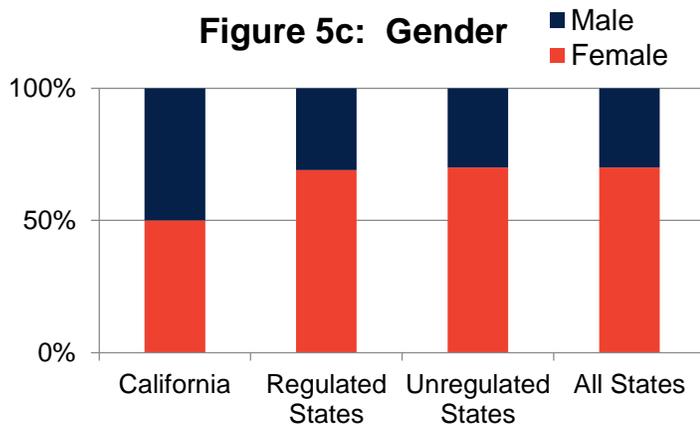


Figure 5c: Gender



Data Source: American Society for Clinical Pathology.
 Proprietary data on newly certified MLTs from 2011-2015.

Scope of Practice

Washington DC and 38 states do not license or regulate MLTs, and those states default to federal CLIA regulations. California and eleven other states regulate MLT practice at the state level. In Figure 7 and Figure 8, the test complexity and supervision laws are compared by state. States that do not regulate MLTs are represented by the entry “CLIA”. State regulations can be more restrictive than the federal CLIA laws, but not less.

Test Complexity

Laboratory tests are classified by CLIA as simple (CLIA-waived), moderate complexity, high complexity, and not classified. CLIA permits MLTs to perform all simple and moderate complexity testing. (§ 493.1421 & §493.1423)¹⁴ CLIA permits MLTs to perform high complexity testing after conducting at least 3 months of documented laboratory training in each specialty in which the individual performs high complexity testing. (§ 493.1489)¹⁴ Among all states, regulated and unregulated, California has the most restrictive scope of practice (Figure 6). MLTs in California are permitted to perform all simple tests (CLIA waived). Moderate complexity testing is limited to the specialties of chemistry, hematology, immunology, and microbiology. However, MLTs in California are prohibited from performing moderate complexity tests in the specialties of microscopy and immunochemistry. High complexity testing is also prohibited for MLTs in California. All other states permit MLTs to perform moderate and high complexity testing. Some states that regulate MLTs limit MLTs from performing tests with results that require interpreting or include supervision provisions on moderate and high complexity tests.

Supervision

CLIA does not specify supervision ratios, allows MLTs to conduct moderate complexity testing without supervision, and requires on-site supervision for MLTs conducting high complexity testing. (§ 493.1425 & §493.1495)¹⁴ California law has the most restrictive supervision requirements of all states, regulated and unregulated (Figure 7). California restricts MLTs to performing only simple tests without supervision. All other states allow MLTs to perform at least some moderate complexity testing without supervision. California restricts MLTs with on-site supervision to moderate complexity testing in the specialties of chemistry, hematology, immunology, and microbiology. California is the only state to specify a supervision ratio, limiting each supervisor to a maximum of four MLTs. West Virginia law explicitly states that no supervision ratio exists for MLTs; all other states do not specify a ratio in the state law.

Less restrictive state laws require that the degree of MLT supervision be determined by the supervisor based on the complexity of the procedure to be performed, the training and capability of the MLT,

and the demonstrated competence of the technician in the procedure being performed. This type of law, similar to the federal law, places control of MLT practice at the practice level rather than the state level.

Specific Tests of Interest to HLWI

Under California law, MLTs are explicitly prohibited from performing moderate complexity microscopy and immunohematology. This provision restricts MLTs from performing microscopic blood smear reviews, microscopic urinalysis, and immunohematologic blood typing (ABO/Rh testing); these are the three tests that the HLWI has identified as potential scope of practice expansion opportunities for California MLTs. Our analysis of state regulations revealed that two states, Nevada and North Dakota, explicitly permit MLTs to perform microscopic urinalysis testing. Only Georgia explicitly permits blood typing. No states explicitly permit blood smear reviews. The three tests were not specified for MLT practice in the remaining states that regulate MLT practice or in CLIA regulations.

Figure 6: Comparison of MLT Scope of Practice Regulations by State, 2016

State	Simple	Moderate Complexity	High Complexity	Blood smear reviews	Microscopic Urinalysis	Blood Typing
California	yes	yes, prohibits microscopy or immunohematology	no	no	no	no
Florida	yes	yes	yes, with training	yes	yes	yes
Georgia	yes	yes	yes, with training	yes	yes	yes
Hawaii	yes	yes	yes, prohibits if the results need interpreting	yes	yes	yes
Louisiana	yes	yes	yes, with supervision	yes	yes	yes
Montana	yes	yes	yes, with training	yes	yes	yes
Nevada	yes	yes prohibits if the results need interpreting	yes, prohibits if the results need interpreting	yes	yes	yes
New York	yes	yes	yes, with training	yes	yes	yes
North Dakota	yes	yes	yes, with training	yes	yes	yes
Rhode Island	yes	yes	yes, with training	yes	yes	yes
Tennessee	yes	yes	yes, with training	yes	yes	yes
West Virginia	yes	yes	yes, with training	yes	yes	yes
Unregulated States (CLIA)	yes	yes	yes, with training	yes	yes	yes

Data Sources: Individual State websites, see References for details. Unregulated states default to federal CLIA regulation

Figure 7: Comparison MLT Supervision Regulations by State

State	Supervision Ratio	Maximum test level without supervision	Maximum test level with supervision	On site supervision required?
California	4 : 1	simple	moderate complexity testing in chemistry, hematology, immunology and microbiology	yes for all moderate complexity testing
Florida	none	moderate	high	yes
Georgia	none	varied	varied	varied
Hawaii	none	high, if no interpretation and no intervention needed	high	yes for high complexity
Louisiana	none	moderate	high	yes
Montana	none	varied	varied	varied
Nevada	none	high, if no interpretation and no intervention needed	high	yes for high complexity
New York	none	moderate	high	yes for high complexity
North Dakota	none	moderate	high	yes
Rhode Island	none	moderate	high	yes
Tennessee	none	moderate	high	yes for high complexity
West Virginia	none	moderate	high	yes for high complexity
Unregulated States (CLIA)	none	moderate	high	yes for high complexity

Data Sources: Individual State websites, see References for details. Unregulated states default to federal CLIA regulations

Impact

For the final objective of the study, we interviewed laboratory personnel located in states that regulate MLTs to better understand the use of MLTs. We conducted interviews with laboratory personnel, most of whom were physicians or PhDs, directing large academic medical center laboratories conducting millions of laboratory tests per year. We also sought out a few smaller hospitals, reference laboratories, an HMO, and a representative from the Department of Defense (DOD) medical operations to provide different perspectives on the impact of MLTs in the laboratory. On average, MLTs comprised 20% of the laboratory staff in the laboratories represented in our sample. The DOD and the reference laboratories employed the highest percentage of MLTs in our sample at 30% and 60%, respectively. Several interviewees noted that they had experienced a higher percentage of MLTs employed in their laboratories prior to licensing and regulation of MLTs in their states. This finding indicates that state-level licensing and regulation may present a barrier to the employment of MLTs.

California MLT laws

The vast majority of interviewees opined that current California MLT laws are too restrictive. One interviewee remarked “California law is too narrow. [It] does not recognize MLT training by limiting complexity. According to CLIA, a high school graduate can do moderately complex tests with training and competency testing.” Another interviewee observed “Restrictive laws create a situation where the letter of the law is followed, but the MLT is capable enough to actually have a positive impact on the productivity of the lab.”

Microscopic Urinalysis

We asked laboratory personnel specifically about expanding the scope of practice for MLTs to perform

microscopic urinalysis, blood smear reviews, and blood typing, the three tests of interest to the HLWI. Respondents were nearly unanimous in support of training MLTs and allowing them to perform microscopic urinalysis testing. Microscopic urinalysis is “not so complex. It is fairly easy to train someone to do urinalysis slide reviews.”

Blood Smear Reviews

Support was less strong for allowing MLTs to perform blood smear reviews. “Blood smear review is a sophisticated test that requires a technologist (CLS). In tertiary hospitals, lymphoma and other unusual results are common and misclassified results are egregious errors. Possibly a technician certificate and special training could be workable.” Another noted, “Even with CLSs, blood smear reviews can be problematic to interpret. It is a complicated skill.” Another respondent thought that MLTs would be capable of blood smear reviews with on-the-job training and recommended limiting early cell identification along with thorough training and competency testing.

Blood Typing

Responses were much less robust for allowing MLTs to perform blood typing. Most interviewees said that MLTs do not conduct blood bank work in their facilities, even in states where it is legally permitted. “I have some reservation for MLTs to work in blood bank due to high consequences of error. Many techs don't even like to work in blood bank.” Another said, “MLTs may not be qualified to do early cell identification in blood smear reviews and advanced blood bank work ups like antibody workups, but they are fine for ABO/Rh testing and cross matching.”

Productivity

Most interviewees noted that well-trained MLTs in the right setting provide a good benefit to productivity. One strong proponent of MLTs remarked, “If I could find more MLTs to hire, I would be happy to use them.” Some laboratory directors felt “boxed in” by state practice laws that limit their ability to optimally use their staff. One interviewee noted that “Overall, MLTs are less productive than CLSs due to the scope of what they can do: training, experience, and regulations.” Another director noted concern about potential pending legal changes in his state, which may decrease the scope of practice for MLTs, deterring him from hiring MLTs even though they are a great benefit to productivity. One interviewee divulged, “My hospital no longer hires MLTs because they must be supervised to release results and cannot operate independently. It’s just not cost-effective to have employees that can’t work independently.”

Decision-Making Skills

When we asked about the quality of work performed by MLTs, a common theme that emerged was the difference between CLS and MLT problem solving, decision-making, and troubleshooting. Many interviewees acknowledged that MLTs often need support to solve problems. “Lab testing is complex; many pre-analytic, analytic, and post-analytic problems can arise. You need to be able to recognize and solve problems.” However, individual variability likely exists. One interviewee noted, “Some CLSs have the degree to work without supervision or conduct high complexity tests, but may not be cognizant or capable.” The difference in decision-making skills may be due to the broader knowledge base and more experience obtained by CLSs in the lengthier CLS education process. A laboratory director mentioned, “When everything is working smoothly, our quality control testing shows MLTs function just as well as CLSs. Troubleshooting

and decision making is where MLTs don't have the expertise of CLSs due to training and knowledge.”

Automation

Many respondents also pointed to the increasing role for MLTs with the increasing automation of laboratory tests, which have quality assurance built into the machines. “MLTs are becoming increasingly more productive in our laboratory as more tests become automated.”

Accuracy

Several interviewees noted that properly trained MLTs are as capable as CLSs. “It has a lot to do with individual training and skill of [the] individual.” “We feel confident in their skills once they have completed our in-house vetting process.” Understanding the impact of MLTs on laboratory safety is an important question in the debate about expanding scope of practice. Do MLTs make more errors than CLSs? No one in our study was willing to comment specifically on accuracy rates between MLTs and CLSs. Future studies are needed to examine the relationship between employing a higher proportion of MLTs and accuracy of test results as measured by proficiency tests, similar to previous studies comparing certified versus noncertified CLSs.^{16,17}

Challenges and Facilitators to MLT Hiring

Interviewees identified several challenges associated with hiring MLTs, including lack of available workforce in the region, tension between CLSs and MLTs, variability in quality of individual MLTs, limitations to scope of practice by state laws, time intensive supervision requirements, increasing laboratory test volume, increasing laboratory test complexity, and fear of errors by a lesser trained workforce. Interviewees also identified facilitators that have supported more MLT hiring, including

increasing automation of laboratory tests that may increase the future role for MLTs, hospitals training or partnering with local schools to offer externships, training and competency testing in-house, expanding opportunities for MLTs in reference labs, and regulating the scope of practice at the practice level.

MLT education pipeline and reexamine the scope of practice laws that govern MLT practice in California.

Practice-Level versus State-Level Regulation

A common theme was a frustration with state level limitations that prohibit laboratory directors from making practice level decisions about “who can do what” in the lab. “Labs are variable, the needs of the community and the hospital are variable, and the available workforce is variable; I need to use every person maximally to keep up with the massive hospital laboratory test workload.” Another interviewee echoed these sentiments, stating that “Training and competency testing at the practice level is ultimately safer than trying to regulate practice at the state level.”

Conclusion

Licensed MLTs were recently introduced into California to alleviate laboratory workforce shortages. Increasing the number of MLTs employed as well as broadening the duties and responsibilities of MLTs are two strategies to address the ongoing laboratory workforce shortages in California. Our study reveals that California’s MLT practice laws are the most restrictive in the country. The numbers of new MLTs entering the California workforce over the last five years are increasing, although the growth is small relative to the population. Laboratory personnel in other states that regulate MLTs generally support MLTs performing moderately complex testing with adequate training, competency testing, and supervision. Given these findings and the laboratory workforce shortages that persist in California, it may be time to expand the

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California

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<http://leg.mt.gov/content/Committees/Interim/2013-2014/Economic-Affairs/Committee-Topics/HB525/ClinLabScientists-Oct2013.pdf>

Nevada

<https://www.leg.state.nv.us/NAC/NAC-652.html#NAC652Sec440>

New York

<http://www.op.nysed.gov/prof/clt/clp-cltlic.htm#cltn>

<http://www.op.nysed.gov/prof/clt/subpart79-15.htm>

North Dakota

<http://www.legis.nd.gov/cencode/t43c48.pdf>

<http://www.legis.nd.gov/information/acdata/pdf/96-02-02.pdf>

<http://www.legis.nd.gov/information/acdata/pdf/96-02-04.pdf>

<http://www.legis.nd.gov/information/acdata/pdf/96-02-10.pdf>

Rhode Island

<http://sos.ri.gov/documents/archives/regdocs/released/pdf/DOH/4960.pdf>

Tennessee

<http://www.lexisnexis.com/hottopics/tncode/>

West Virginia

https://www.wvdhhr.org/labservices/shared/docs/Licensure/Personnel_licensure_extract.pdf

Appendix

Appendix 1: Comparison of California Laboratory Professional Designations

Name	EDUCATION	SUPERVISION			SCOPE OF PRACTICE									
	Education Level	Maximum FDA test level without supervision	Maximum FDA test level with supervision	On site supervision required?	Simple (CLIA waived)	Moderate Complexity	High Complexity	Blood smear reviews	Microscopic Urinalysis	Blood typing	Perform phlebotomy	Report results	Direct Lab	Direct hospital lab
Board Certified Pathologist	Doctorate, Pathology Board Certification	high complexity	N/A	no	Y	Y	yes	Y	Y	Y	Y	Y	Y	Y
Physicians	Doctorate	high complexity	N/A	no	Y	Y	yes	Y	Y	Y	Y	Y	Y	no
Clinical Lab Scientists	Baccalaureate	high complexity	high complexity	no	Y	Y	yes, cytology, pathology prohibited	Y	Y	Y	Y	Y	no	no
Clinical Lab Specialists	Baccalaureate	high complexity, in specialty	high complexity, in specialty	no	Y	Y	yes, in specialty	Y	Y	Y	Y	Y	no	no
Medical Laboratory Technicians	Associate or 3 years of practical experience	simple	only in chemistry, hematology, immunology, microbiology	yes, for all moderate complexity testing	Y	yes, microscopy & immuno-hematology prohibited	no	no	no	no	Y	Y	no	no
Lab aides	HS diploma competency test	none	none	Y	no	no	no	no	no	no	no	no	no	no
Phlebotomy technician	HS diploma competency test	none	none	Y	no	no	no	no	no	no	Y	no	no	no

Data Sources: California Legislation Websites, See References for details

Appendix 2: Supply Data

Appendix 2a: Supply Data for Regulated States, 2015

Regulated States	Population	# MLTs	MLTs per 100,000 population	MLT programs	New MLTs (2011-2015)	Mean Age	Percent Female	Mean Wage (\$/hour)
California	39,144,818	17,670	45	4	457	30	50%	\$22.95
Georgia	10,214,860	4,800	47	11	448	34	75%	\$18.09
Florida	20,271,272	6,160	30	5	371	33	65%	\$18.00
New York	19,795,791	7,440	38	7	336	33	63%	\$22.59
Tennessee	6,600,299	6,740	102	6	279	33	78%	\$17.62
Louisiana	4,670,724	2,580	55	5	152	32	86%	\$16.19
West Virginia	1,844,128	760	41	4	137	30	71%	\$18.39
Hawaii	1,431,603	630	44	1	94	30	56%	\$22.38
Rhode Island	1,056,298	380	36	1	66	35	74%	\$28.43
North Dakota	756,927	270	36	2	62	31	84%	\$20.06
Nevada	2,890,845	840	29	1	46	33	55%	\$19.96
Montana	1,032,949	400	39	0	24	32	70%	\$20.71

Data Sources:

Population: United States Census Bureau. QuickFacts California. 2016; <http://www.census.gov/quickfacts/table/PST045215/06>. Accessed October 2016.

MLTs: Individual State Licensing Boards, Proprietary data on number of licensed MLTs as of December 2016.

MLT programs: National Accrediting Agency for Clinical Laboratory Sciences. <http://www.naacls.org>. Accessed October 2016.

New MLTs, Mean Age, Percent Female, Mean Wage: American Society for Clinical Pathology. Proprietary data on newly certified MLTs from 2011-2015.

Appendix 2b: Supply Data for Unregulated States, 2015

Unregulated States	Population	MLT programs	New MLTs (2011-2015)	Mean Age	Percent Female	Mean Wage (\$/hour)
Alabama	4,858,979	4	277	32	75%	\$17.09
Alaska	738,432	0	39	30	56%	\$23.37
Arizona	6,828,065	3	163	33	53%	\$19.74
Arkansas	2,978,204	6	131	32	73%	\$17.48
Colorado	5,456,574	2	187	34	67%	\$19.48
Connecticut	3,590,886	0	28	30	31%	\$23.95
Delaware	945,934	1	36	31	79%	\$21.20
Idaho	1,654,930	0	26	33	73%	\$15.92
Illinois	12,859,995	7	337	33	75%	\$22.10
Indiana	6,619,680	8	336	35	81%	\$17.81
Iowa	3,123,899	4	225	33	83%	\$20.36
Kansas	2,911,641	3	101	32	73%	\$18.08
Kentucky	4,425,092	7	228	33	72%	\$19.45
Maine	1,329,328	1	74	37	69%	\$19.18
Maryland	6,006,401	6	353	32	61%	\$19.98
Massachusetts	6,794,422	6	208	34	71%	\$20.61
Michigan	9,922,576	4	297	32	73%	\$17.13
Minnesota	5,489,594	14	641	33	75%	\$21.64
Mississippi	2,992,333	7	277	30	87%	\$17.07
Missouri	6,083,672	5	191	34	73%	\$18.15
Nebraska	1,896,190	3	141	31	73%	\$18.61
New Hampshire	1,330,608	1	44	37	76%	\$19.74
New Jersey	8,958,013	3	150	34	66%	\$23.26
New Mexico	2,085,109	3	74	36	67%	\$19.61
North Carolina	10,042,802	14	552	34	77%	\$19.30

continued...

Appendix 2b continued: Supply Data for Unregulated States, 2015

Unregulated States, continued	Population	MLT programs	New MLTs (2011-2015)	Mean Age	Percent Female	Mean Wage (\$/hour)
Ohio	11,613,423	15	752	33	72%	\$20.48
Oklahoma	3,911,338	5	245	34	70%	\$15.97
Oregon	4,028,977	1	158	35	72%	\$20.20
Pennsylvania	12,802,503	14	390	34	75%	\$20.22
South Carolina	4,896,146	7	382	33	76%	\$17.98
South Dakota	858,469	2	69	28	84%	\$17.04
Texas	27,469,114	21	1,172	32	67%	\$18.74
Utah	2,995,919	1	162	30	59%	\$16.13
Vermont	626,042	0	14	32	62%	\$26.47
Virginia	8,382,993	5	359	32	65%	\$18.78
Washington	7,170,351	3	316	35	61%	\$21.86
Washington DC	672,228	0	8	35	43%	\$22.20
Wisconsin	5,771,337	10	523	33	79%	\$22.75
Wyoming	586,107	1	42	32	75%	\$20.39

Data Sources:

Population: United States Census Bureau. QuickFacts California. 2016; <http://www.census.gov/quickfacts/table/PST045215/06>. Accessed October 2016.

MLT programs: National Accrediting Agency for Clinical Laboratory Sciences. <http://www.naacls.org>. Accessed October 2016.

New MLTs, Mean Age, Percent Female, Mean Wage: American Society for Clinical Pathology. Proprietary data on newly certified MLTs from 2011-2015.

Appendix 2c: Summary Statistics of State Data, 2015

Regulated States	Population	# MLTs	MLTs per 100,000 population	MLT programs	New MLTs (2011-2015)	Mean Age	Percent Female	Mean Wage (\$/hour)
sum	109,710,514	48,670	44	47	2,472			
mean	9,142,543	4,056	45	4	206	32	69%	\$20.45
standard deviation	11,748,762	5,093	19	3	162	2	11%	\$3.31
Unregulated States								
sum	211,708,306	N/A	N/A	197	9,708			
mean	5,428,418	N/A	N/A	5	249	33	70%	\$19.73
standard deviation	4,994,307	N/A	N/A	5	234	2	11%	\$2.37
All States								
sum	321,418,820	N/A	N/A	244	12,180			
mean	6,302,330	N/A	N/A	5	239	33	70%	\$19.90
standard deviation	7,201,100	N/A	N/A	4	185	2	11%	\$2.60

Data Sources:

Population: United States Census Bureau. QuickFacts California. 2016; <http://www.census.gov/quickfacts/table/PST045215/06>. Accessed October 2016.

MLTs: Individual State Licensing Boards, Proprietary data on number of licensed MLTs as of December 2016.

MLT programs: National Accrediting Agency for Clinical Laboratory Sciences. <http://www.naacls.org>. Accessed October 2016.

New MLTs, Mean Age, Percent Female, Mean Wage: American Society for Clinical Pathology. Proprietary data on newly certified MLTs from 2011-2015.

Appendix 3: Interview Guide

Background Questions:

1. Describe the overall organization: brief history, type of organization, size and scope.
2. Describe the lab:
 - a. Number and type of employees
 - b. Volume
 - c. Type of tests
3. General information on staff:
 - a. What is the current pay range for MLTs in your organization as compared to CLS' and other laboratory assistants, if any? Please indicate the overall pay range, including starting pay.
 - b. If wages are not available, give us an idea of how the MLT wage compares to the CLS wage.
 - c. How do you staff MLTs in terms of ratios to CLS for supervision?
4. When and why did this laboratory start hiring MLTs?
 - a. What was that like?
 - b. How is the workflow here different now?
 - c. What impact do MLTs in your laboratory have on:
 - i. Productivity?
 - ii. Safety?
 - iii. Quality?

MLT Scope of Practice Questions:

5. Interviewer: Describe the scope of practice for MLTs in California.
 - a. How does the MLT scope of practice in California differ from your state?
 - b. Is the MLT scope of practice in California too narrow, too broad, or just right?
 - i. Why?
6. Interviewer: Describe the scope of practice for MLTs in the interviewees' state.
 - a. Is the scope of practice for MLTs in your state too restricted, too broad, or just right?
 - i. Why?
 - b. Are any of the items carried out differently in practice than prescribed by the law?
 - c. Are there other regulatory factors, in addition to scope of practice laws in your state that encourage or discourage the use of MLTs?
 - d. If the MLT scope of practice were to be modified in your state, what responsibilities would you recommend adding or taking away?
 - i. Why?
7. Does allowing MLTs to conduct the following specific tests impact laboratory productivity or raise concerns regarding the quality of testing?
 - a. Blood smear reviews
 - b. Urinalysis
 - c. Moderately complex ABO/Rh tests

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