WHEN THE WELL RUNS DRY: HOW TO SURVIVE THE MEDICAL LABORATORY SCIENCE DROUGHT

A Thesis

by

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ABSTRACT

There is a growing shortage of medical laboratory science (MLS) workers across the United States. Currently, there are not enough graduates of medical laboratory science programs to fill job vacancies in clinical laboratories. There is limited literature pertaining to how medical laboratory science programs are recruiting students and retaining them to successfully graduate. This study evaluated medical laboratory science programs to assess their needs in order to graduate students to enter the workforce.

An electronic survey was sent to 230 medical laboratory science program directors across the United States (U.S.), and 81 program directors responded (35.2% response rate). The survey responses were analyzed using quantitative methods with a combination of descriptive and nonparametric statistics. Multiple barriers were found with student recruitment and retention among respondents such as a lack of recognition for the profession as a whole, salary rates for the profession compared to other healthcare professions, students being dismissed from the program due to academic rigors, and lack of clinical rotation sites. Strategies used to overcome barriers were giving presentations at career fairs, seeking out additional affiliates for clinical rotations, and providing online coursework to give program flexibility. These results provide a starting point on how MLS programs can increase the number of graduates entering the profession.

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Contributors

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NOMENCLATURE

ASCP	American Society for Clinical Pathology
AAB	American Association of Bioanalysts
AMT	American Medical Technologists
BOC	Board of Certification
MLS	Medical Laboratory Science
MLT	Medical Laboratory Technician
NAACLS	National Accrediting Agency of Clinical Laboratory Science
STEM	Science, Technology, Engineering and Math

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CHAPTER I

INTRODUCTION

Statement of the Problem

Clinical laboratories across the U.S. are experiencing a severe shortage of qualified employees and struggle to fill vacancies within their organizations. Medical laboratory scientists, referred to as lab scientists for short, are of vital importance to healthcare. These professionals work in a variety of settings including hospitals, reference laboratories, physician offices, and clinics, and run diagnostic tests for healthcare providers. These tests allow providers to accurately diagnose conditions such as myocardial infarction and leukemia, or provide compatible blood products for a transfusion. There is increasing concern that this workforce shortage is growing due to baby boomers reaching retirement age and not having enough new graduates to replace them. While the public may not know about this problem, those working in this profession are aware of the strain this shortage causes. Despite this concern, no study has investigated what Medical Laboratory Science (MLS) training programs are doing to combat this trend or documented what programs need in order to increase the number of graduates annually.

Purpose of Study

To address the issue of the workforce shortage in the clinical laboratory, MLS program directors in the U.S. were surveyed to identify strategies they use and barriers they experience in recruiting and retaining students in their program. In addition,

participants were asked questions about their opinion on the workforce shortage and about retaining new graduates in the medical laboratory science profession. Improving the workforce shortage can be helped by increasing the number of new graduates, retaining more employees in the field, as well as delaying retirement for older employees. This study aims to propose solutions that programs can implement to increase the number of new graduates entering the workforce annually, as well as suggestions that the profession can use to retain new graduates, once hired.

Research Questions

1. How do MLS programs recruit qualified students, and do they encounter any barriers in recruitment?
2. What issues or barriers are experienced by MLS programs that hinder their ability to graduate students?
3. Are there any factors that support or hinder retention of new graduates after they enter the workforce?

CHAPTER II

LITERATURE REVIEW

The Profession

Medical laboratory scientists are the professionals responsible for testing blood, urine, and other miscellaneous sterile and non-sterile specimens to aid healthcare practitioners with the diagnosis, treatment, and management of diseases (A. S. o. C. L. Science, 2018). Specifically, lab scientists are involved with the pre-analytical (selection of specimen containers and transport), analytical (testing procedures), and post-analytical (interpreting and reporting of testing results) aspects of testing clinical specimens (Kaplan & Burgess, 2010). Due to the level of detail required to produce test results, the clinical laboratory is a highly regulated area of healthcare both from federal and state governments and several regulatory agencies (Passiment, 2006).

In general, those working in the clinical laboratory hold the title of medical laboratory scientist or medical laboratory technician. A medical laboratory scientist holds a bachelor's degree, and a medical laboratory technician holds an associate's degree. Depending on the state and the culture of any individual organization, the day-to-day job duties may not differ between a medical laboratory scientist and a medical laboratory technician (Doig, Beck, & Kolenc, 2001). There are a few states, California and Louisiana in particular, that do not allow a medical laboratory technician to perform high-complexity testing (primarily testing that requires a manual analysis).

MLS Training Programs

MLS programs vary on their specific structures in terms of time to complete the program, number of hours spent in clinical rotations, and program type. All MLS programs in the U.S. must be accredited by the National Accrediting Agency of Clinical Laboratory Science (NAACLS) which establishes educational standards for all laboratory professional programs such as those in medical laboratory science, pathology assistant, histology, and phlebotomy. MLS programs can be either university-based or hospital-based. University-based programs require students to complete their classes at the school before continuing onto a final internship year at an affiliated hospital (Scanlan, 2013). Hospital-based programs are run directly at the clinical training site and host a combination of didactic lectures and clinical rotations. Unlike university programs, hospital programs do not award degrees to students directly. Instead, students receive a certificate of completion that can be applied toward a degree (Scanlan, 2013). Students graduating from MLS programs can be either 3+1 or 4+1 students. Students designated as 3+1 will obtain a bachelor's degree upon graduation; whereas 4+1 students already have a bachelor's degree (typically in biology or other biological sciences) and will obtain a certificate of completion from the program (Hammerling & van der Heyden, 2011; Scanlan, 2013).

Passing a certification exam at the end of the MLS program is vital and establishes professional competency for all MLS professionals (Scanlan, 2013). In the U.S., students can obtain certification from one of these three organizations: American Society for Clinical Pathology (ASCP), American Medical Technologists (AMT) and

American Association of Bioanalysts (AAB) (Scanlan, 2013). ASCP's Board of Certification (BOC) exam is considered to be the most widely accepted by employers. Certification is not legally mandated nation-wide in the same way that other healthcare providers are expected to certify such as nursing, respiratory therapists, and radiology technicians (Rohde, Falleur, & Ellis, 2015). However, most employers stipulate that an individual be certified in order to work at their organization. The issue of non-mandated certification is a controversial topic within the profession (Delost, Miller, Chang, Korzun, & Nadder, 2009; Rohde et al., 2015). To prevent non-certified individuals from working in the clinical laboratory, several U.S. states require a state license to work in addition to certification. Specific requirements for each state can vary greatly. At this point in time, there is no literature showing if state licensure creates an additional barrier for workers and exacerbates the overall vacancy rate in the profession.

Program Closures

The shortage of available lab scientists can be alleviated by graduating more certified medical laboratory scientists to fill job openings; however, program closures across the U.S. makes this task difficult. In 2000, there were 263 MLS programs, but this number has decreased to 234 MLS programs in 2017 (A. S. o. C. L. Science, 2018). Despite MLS programs closing, the number of MLS graduates has increased over the past 15 years with 3,894 students graduating in 2017, showing that programs are becoming more efficient in graduating their students (Cearlock & Swartz, 2018). While these numbers indicate promise, they do not cover the 42,700 jobs that are expected to

be created in the clinical laboratory between 2016-2026 (U.S. Department of Labor, 2019).

One reason for program closures is that MLS programs are expensive to operate mainly due to the required laboratory classes and equipment. Both program types face constant scrutiny due to the large cost required to maintain these programs and the relatively low number of student graduates (A. S. o. C. L. Science, 2018). Hospital-based programs have an added strain due to implementation of the Medicare Prospective Payment Systems causing hospitals to reorganize their payment structure and subsequently turning medical laboratories into cost centers rather than sources of revenue (Bennett et al., 2014). With many organizations undergoing budget cuts, programs are finding themselves in an increasingly financially precarious position.

These closures are concerning not only because of an overall lack of incoming students, but because many students obtain employment in the state where they attend school (Enrado, May 13, 2009). Program closures have left several states with only one NAACLS program to serve the entire area, thereby impacting the number of graduates who enter the available employee pool in that area. Not everyone can relocate their lives for school, and this leaves job openings unfilled, particularly in rural areas. Bearce, Spiegel, and Hulse (2017), outlined how rural critical access hospitals in Idaho struggle to fill their laboratories and provide healthcare to patients who live remotely. These hospitals previously had a steady influx of new graduates to staff these rural laboratories. However, due to the closure of five NAACLS-accredited MLS programs in Idaho, the number of students available to fill these rural laboratory vacancies has decreased by

83% (Bearce, Spiegel, & Hulse, 2017). This leaves hospitals unable to staff their laboratory adequately and causes delays in caring for rural patients.

The Workforce Shortage

Most of the public does not know that the profession of medical laboratory science exists, thereby exacerbating the fact that the growing shortage of medical laboratory scientists goes largely unnoticed outside of the field. ASCP published a vacancy survey in 2017 estimating shortages across all laboratory departments. It reported that the number of job applicants has decreased in relation to retiring personnel and some departments are expecting 20% of their staff to retire in the next 5 years (Garcia, Kundu, Ali, & Soles, 2018). The Bureau of Labor Statistics estimates a 12% increase in open positions for laboratory scientists between 2016-2026 due to employees retiring from the profession as well as meeting the health needs of a large aging population (A. S. o. C. L. Science, 2018). Overworking and staff burn out is becoming an increasing concern as laboratories try to schedule their often 24/7 facilities with a very limited staff. Many lab scientists are jumping ship, from their current facilities and from the profession overall, due to work burn out and substandard salaries. But as one report stated, "medical laboratory professionals will continue to do what is necessary to provide quality lab results, at the expense of their work/life balance" (A. S. o. C. L. Science, 2018).

To combat the growing vacancies, many healthcare organizations have increased the hiring of individuals who have bachelor's degrees but no formal clinical laboratory education in an attempt to relieve the workload of an already stained staff (Garcia,

Kundu, Ali, et al., 2018). It is understandable why organizations have taken this route; staff is needed, and practitioners and their patients need test results. However, this practice is concerning because the clinical laboratory is a specialized area of healthcare that requires background knowledge to ensure that accurate patient results are being reported. Individuals without formal clinical laboratory science education are more likely to produce unacceptable results in proficiency testing compared to those who have completed a medical laboratory science program (Delost et al., 2009). If laboratory professionals are obtaining incorrect values in proficiency testing, there is a chance they are obtaining—and verifying into the medical record—inaccurate patient results. This serves to further highlight the importance of educating and graduating qualified individuals into the clinical laboratory.

Barriers

One of the first barriers to increasing the number of students entering the profession is simply the lack of knowledge that the profession exists in the first place. Many people do not know who performs their diagnostic tests after getting their blood drawn, and therefore, the general public and prospective students are unaware of this career path. In fact, many people, high school students included, think that doctors and nurses perform laboratory testing (Haun, Leach, Lawrence, & Jarreau, 2005). Medical laboratory scientists do not work in areas that typically have patient contact. Even in hospitals, laboratories are typically housed in the basement away from patients. As one study describes, even if the laboratory scientists perform everything perfectly in regards to patient testing, "we are still invisible" (Kaplan & Burgess, 2010). This invisibility

and lack of direct patient contact can be a draw for any in the profession, but is also causing difficulties in recruiting prospective students into the field.

In addition to a lack of awareness about the profession, medical laboratory science is not perceived as a profession that has many career advancement opportunities (McClure, 2009). Students are often motivated to enter into a profession based on the job outlook in that field, which includes any opportunity for leadership advancement (Barfield, Folio, Lam, & Zhang, 2011). While MLS students are excited about a career as a laboratory scientist, many individuals are looking for opportunities to advance in their career which they do not readily see in the clinical laboratory (McClure, 2009).

Another major barrier to increasing the number of graduates is the inability to place students in clinical rotations (Renfro, 2015; A. S. o. C. L. Science, 2018). Clinical rotations are an essential part of an MLS program where students get hands-on experience working in the laboratory. But because of the staff shortages, laboratories are hesitant to take on students to train. Training students is time intensive, and when laboratory scientists have a large workload, they may not have time to train students in addition to their benchwork.

Implication of the Study

Within the field, the growing workforce shortage has been outlined multiple times in the literature but with a focus on how employers can retain individuals who are already working (Beck & Doig, 2005; Schill, 2017; Slagle, 2013). There is very limited literature examining how MLS programs nation-wide can aid in decreasing the workforce shortage (Kovach, 2015). A few local studies have focused on how

educational programs themselves can recruit and retain students to join this profession (Flores, 2010; Garcia, 2015; Nasr & Jackson-Harris, 2016; Renfro, 2015).

This study builds upon the results obtained by Renfro (2015) and Kovach (2015), and by surveying all programs in the nation, produced generalizable results to propose solutions that can attract students to this field. Using descriptive and nonparametric statistical analysis, the most impactful issues were identified, and from there, solutions on how to overcome these issues were proposed to increase student recruitment and retention within the MLS programs and the profession overall.

CHAPTER III

METHODS

Research Design

This project included the use of an electronic survey sent to all MLS program directors in the U.S. The survey was administered through an online survey program, Qualtrics®, to facilitate an easier response process and maximize the response rate. The survey included 29 questions total and included a variety of questions based on potential problems identified from existing literature (see Appendix A). The survey included questions about assessing strategies used in recruiting students to the program, issues encountered in successfully graduating students, and possible factors affecting retention of new graduates once they enter the workforce. The barriers and strategies mentioned in the survey were developed from a review of the literature as common problems MLS programs are facing. The questions were formatted as short answer (15 words or less), multiple-choice questions, or ranking questions. Data was analyzed using descriptive statistics and several nonparametric statistical tests to find the most common barriers and successful strategies used by the MLS programs. This research project received approval from the Texas A&M University Institutional Review Board on July 1, 2019 (see Appendix B).

Sampling Plan

The sample population for this study included all of the NAACLS-accredited MLS programs in the U.S. that are currently accepting students. This included 95

hospital-based programs and 135 university-based programs for a total of 230 participants. The program directors solicited for survey participation run the program on a day-to-day basis and are knowledgeable about the students who enter the program as well as recruitment strategies used to attract students into the profession. The list of accredited programs in the U.S. is maintained by NAACLS, and the list also includes contact information for the program directors (N. A. A. o. C. L. Science, n.d.). The list of participants to contact was compiled in March 2019. Due to the relatively small population size, the decision was made to survey all U.S. programs to obtain the greatest possible number of responses.

Validity

Validity for the survey instrument was done with *content validity* through a review by experts on the subject. A thesis advisory committee of three faculty members, one of whom is the medical director of an MLS program, reviewed the survey instrument. Additional experts were consulted in a pilot study conducted with 12 program directors over the course of 1 week. Only 2 directors responded to the pilot study, but no problems were reported with the survey program and/or instrument itself, and the project continued as planned.

Reliability

Survey reliability was measured using the internal reliability of correlation among survey items. Internal reliability was measured with Cronbach's coefficient alpha and the Kuder-Richardson formula. Both of these estimate the degree in which scores from survey questions measure the same concept (Ritter, 2010). Since this survey

is measuring three concepts, all three concepts had their own reliability scores calculated depending on the question type. Cronbach's alpha is used to evaluate multiple-choice items (Ritter, 2010), whereas, the Kuder-Richardson formula is used for the dichotomous test items (Kuder & Richardson, 1937). A value of >0.70 for both reliability tests is considered to show good internal reliability among a group of test items. Table 1 outlines the reliability tests that were used for each section of the survey.

Table 1: Summary of internal reliability testing

Survey Item #	Research Section	Reliability Test
7, 8, 9, 10, 12	Recruitment	Cronbach's Alpha
13, 14, 20, 21, 23	Program Barriers	Cronbach's Alpha
15, 16, 18, 22, 24	Program Barriers	Kuder-Richardson Formula
25, 26, 27	Workforce Retention	Cronbach's Alpha

Data Analysis

The primary purpose of this study was to identify strategies and barriers MLS programs encounter with student recruitment and graduating their students. Therefore, most of the data analysis plan was performed using descriptive statistics to identify the most common strategies and barriers that MLS programs encounter. Table 2 represents a summary of descriptive statistics that were used in this study to help identify these specific strategies and barriers. Data analysis was completed with Microsoft Excel and utilized the XLSTAT add-in for the nonparametric testing procedures.

Table 2: Summary of descriptive statistics

Survey Item #	Research Section	Statistical Analysis
1-6	Demographic	Frequencies, Mean, Median, Mode, Standard Deviation
7-14	Recruitment	Frequency Distribution, Weighted Average
15-24	Program Barriers	Frequencies, Percentages
25-29	Workforce Retention	Frequencies, Percentages, Weighted Average

Nonparametric statistics were used to determine if any differences existed among groups of respondents. To determine if relationships existed among the "check all that apply" (CATA) questions, Cochran's Q test was utilized to determine if each response option had identical effects. The Cochran test determines if a set of treatments are equally effective within a block (Conover, 1999). In the context of this study, the block included all participants who answered the CATA questions. The treatments refer to the "yes" or "no" selection of each available answer choice. The null hypothesis tested with the Cochran test states that the treatments are equally effective within a block. Rejecting the null hypothesis shows a difference in the treatments (Conover, 1999). This test was used in conjunction with frequency distributions to determine if there is any difference in how participants scored the CATA questions. If the null hypothesis was rejected, a post-hoc was done with multiple pairwise comparisons using the critical difference between two treatments within XLSTAT.

Ranking questions were analyzed with the Skillings-Mack test. The ranking questions asked participants for their top 3 answer choices, but list more than three answer options creating missing data within the block design. The answer choices were

ranked by participants with 1 being the most important and 3 being the least important. The Skillings-Mack test determined if there was any difference among the rankings for each individual answer choice (Chatfield & Mander, 2009). The null hypothesis states that all treatments are equal, and the alternate hypothesis states that there is a difference among the treatments (Chatfield & Mander, 2009). If the null hypothesis was rejected, multiple pairwise comparisons were done to determine which answer choice was significantly different. The ranking questions allow participants to provide additional information on their thoughts on the primary factors affecting the workforce shortage and recruitment strategies.

CHAPTER IV

RESULTS

Response Rate

The survey opened July 15, 2019, and closed August 11, 2019. A total of 86 program directors began the survey. Of these 86 program directors, five did not complete the survey past the initial consent question, and therefore, were not used in further analysis. The total number of surveys used in data analysis was 81 resulting in a 35.2% response rate. The average time to complete the survey was 65.4 minutes which included any time spent "pausing" the survey. The long duration was because the survey was built with the ability for participants to pause their responses and return later if they chose to do so.

Reliability Testing

The reliability scores are shown in Table 3. All groups scored are below 0.70 which is the acceptable reliability score for a survey instrument.

Table 3: Instrument reliability

Reliability Test	Research Section	Reliability Score
Cronbach's Alpha	Recruitment (n=5)	0.292
Cronbach's Alpha	Program Barriers (n=5)	-0.271
Kuder-Richardson	Program Barriers (n=5)	0.257
Cronbach's Alpha	Workforce Retention (n=3)	0.354

Demographics

The demographic information collected included program location and type of program, as well as information on the number of applicants, class size, number of graduates per year, and the certification exam pass rate. This demographic information is shown in Figure 1 and Table 4.

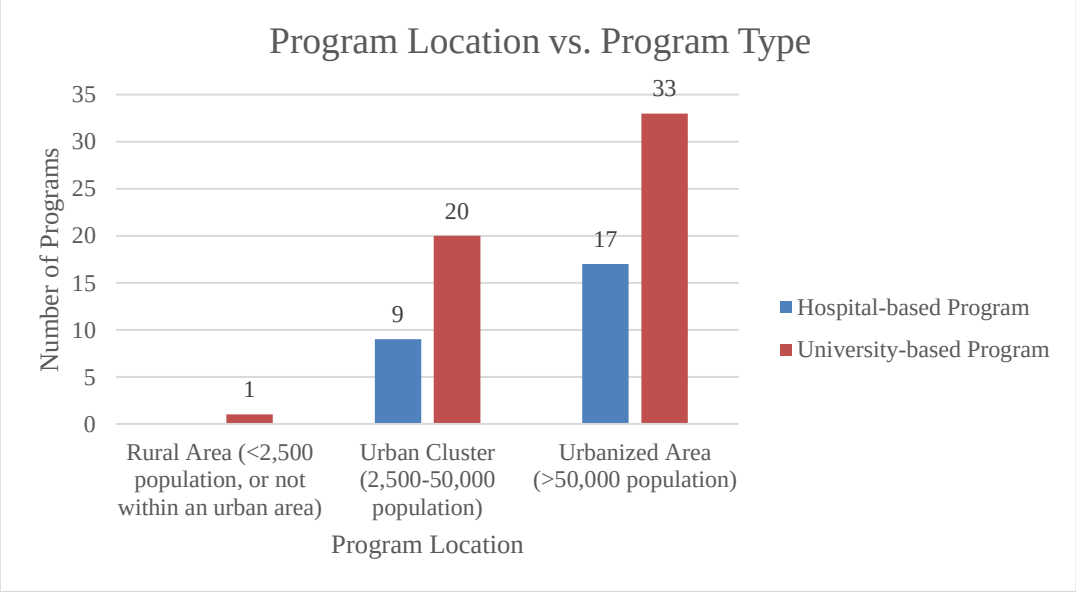

Figure 1: Location of MLS program directors who responded and their respective program types

Table 4: Number of applicants, graduating class size, and certification exam pass rates for MLS programs

	Applicants per year (students)	Applicants Accepted per year (students)	Graduating Class per year (students)	Certification Exam Pass Rate (%)
Mean	45.3	22.3	20.0	93.0
Median	30	18	16	96
Mode	30	8	20	100
SD	53.0	21.5	16.9	8.1

The average number of applicants for the MLS programs was 45.3 students. However, as seen in Table 4, this number varied greatly among the sample with a standard deviation (SD) of 53.0. The median applicant pool has about 30 students. The average number of students accepted into an MLS program is 22.3 students. Again, the spread of accepted students was large (SD=21.5) due to specific program structures such as the number of instructors, available classroom space, etc. Most programs had a small class size as seen in Figure 2. The final graduating class size decreased further with an average graduating class of 20 students. The average certification exam pass rate was 93%.

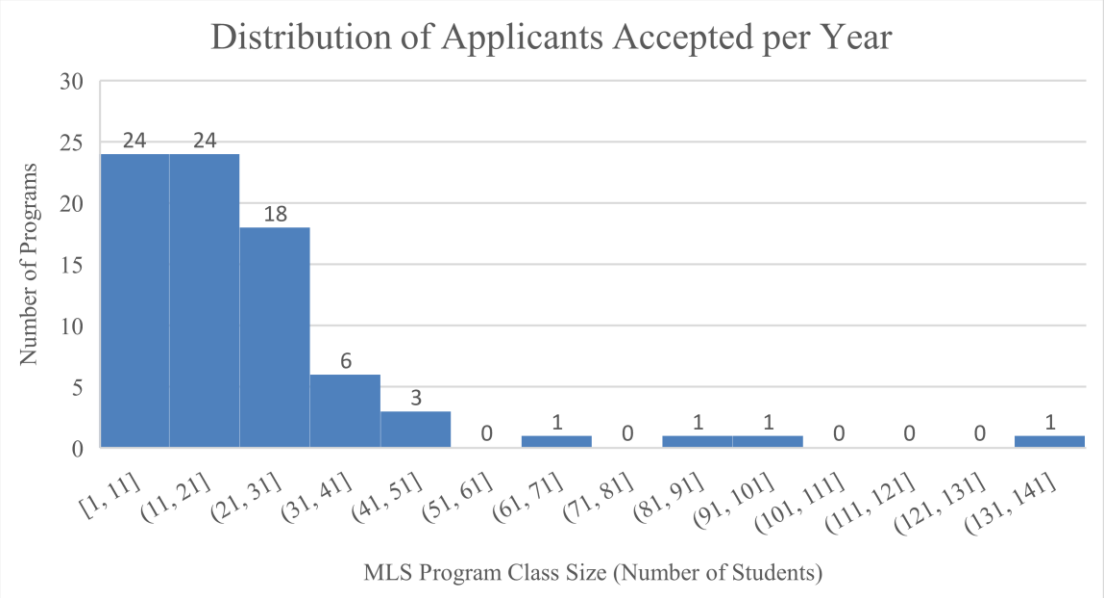

Figure 2: Distribution of MLS program class size

Barriers to Recruitment

The respondents were asked if there has been a change in the number of applicants over the past 5 years. Respondents were evenly split when asked if they have seen a change in the number of applicants applying to their program (Increase = 29.6%, Decrease = 37.04%, No Change = 32.1%) as shown in Figure 3. When asked to quantify the change, 37.0% (n=30) of respondents reported a change of less than 25% (increases and decreases). This was followed by 32.1% (n=26) who reported no change and 24.6% (n=20) who reported a 26-50% change (increases and decreases) (see Figure 3).

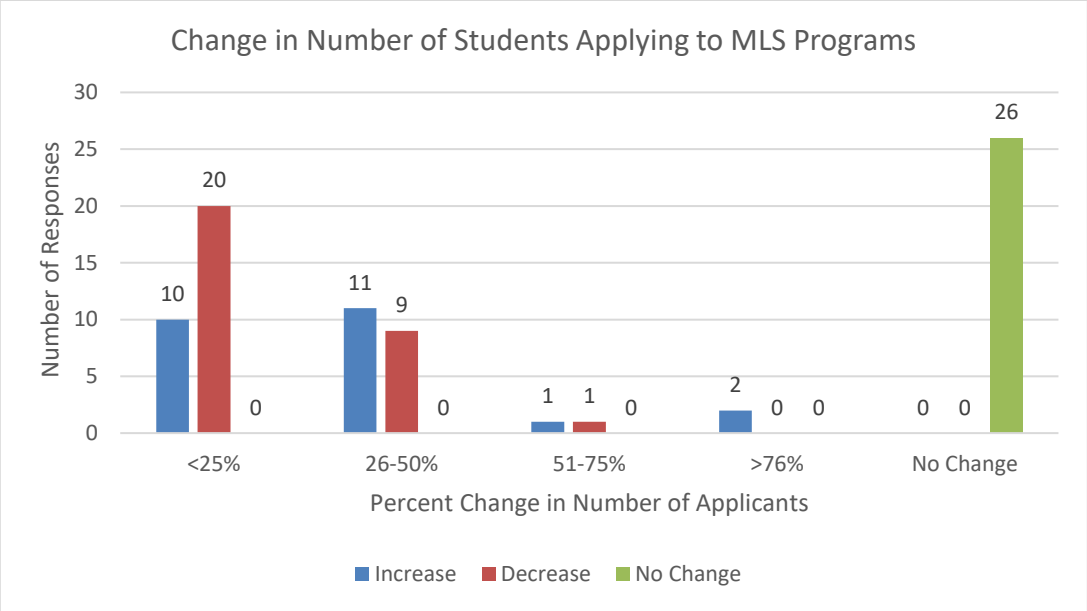

Figure 3: Changes in the number of students applying to MLS programs

When asked about specific barriers to student recruitment, 91.4% of respondents stated that the main barrier was that students are unaware of medical laboratory science as a career (Cochran's Q=127.598, p<0.0001). Other barriers identified were difference in wages compared to other healthcare professions (63.0%), lack of program flexibility (37.0%), lack of upward mobility on the professional ladder (12.3%), and cost of program tuition (23.5%) (see Table 5). The null hypothesis for Cochran's Q was rejected, and multiple pairwise comparisons were completed to determine which barrier(s) were responsible for the significant difference. "Students unaware of Medical Laboratory Science as a career" was significantly different from the other strategies in the question. "Difference in wages compared to other healthcare fields" was also significantly different from other strategies listed.

Table 5: Barriers to MLS programs in recruiting qualified students

Barrier	Total Respondents	Frequency
Students unaware of Medical Laboratory Science as a career	74	91.36%
Difference in wages compared to other healthcare fields	51	62.96%
Lack of program flexibility	30	37.04%
Lack of upward mobility on the professional ladder	10	12.35%
Cost of program tuition	19	23.46%

Program directors were asked to check all that apply to strategies they employ when recruiting students to their program. The strategies most often used to recruit students to their programs were "collaboration with academic advisors" (90.9%), "pamphlets/flyers around your institution/affiliates" (85.7%), and "career fair presentations" (80.5%) (Cochran's $Q=78.913$, $p<0.0001$) (see Table 6). There were very few program directors who utilize pipeline programs with high-school aged students (37.6%). The null hypothesis for Cochran's Q was rejected, and multiple pairwise comparisons were done to determine the significant recruitment strategy. There was no significant difference between "pamphlet/flyers", "career fair presentations", and "collaboration with academic advisors". However, all three of these strategies did show a significant difference from "utilization of pipeline programs with high-school aged children."

Table 6: Strategies used to recruit students to MLS programs

Strategy	Total Respondents	Frequency	Average Rank
Pamphlets/flyers around your institution/affiliates	66	85.71%	2.3
Career Fair Presentations	62	80.52%	2.1
Collaboration with academic advisors	70	90.91%	1.4
Utilization of pipeline programs with high-school aged children	29	37.66%	3.0

To quantify how heavily each strategy was used and its importance in student recruitment, participants ranked the strategies in order of importance, with 1 being the most important and 3 the least important. Collaborating with academic advisors had an average rank of 1.4, followed by career fair presentations with a rank of 2.1, pamphlets/flyers average rank was 2.3, and utilization of pipeline programs with high-school aged students had an average rank of 3.0 as seen in Table 6 (Skillings-Mack $Q=44.389$, $p<0.0001$). A post-hoc test of multiple pairwise comparisons was applied and showed a significant difference between collaboration with academic advisors and the other strategy choices. There was also a significant difference between utilization of pipeline programs and the rest of the strategies. There was no significant difference seen between pamphlets/flyers and career fair presentations.

In addition to recruitment strategies for university students, respondents were asked if they participated in any outreach events, particularly ones directed towards younger (middle/high school) students (see Table 7). The most common strategies implemented were presentations at career fairs (73.8%) followed by giving lab tours to

middle/high school students (65.0%) (Cochran's Q=83.808, p<0.0001). Over half of respondents (53.8%) give career fair presentations specifically to middle/high school students.

Interestingly, 33.8% of program directors who are affiliated with a STEM pipeline program, and 8.8% of program directors who do not participate in any outreach events. Post-hoc multiple pairwise comparisons test was applied to determine which strategy was responsible for the significant difference. There was no significant difference between presenting at career fairs and giving lab tours to middle/high school students. There also was no statistical difference between participating in a career day for middle/high school students and the other strategy choices. Affiliation with a STEM pipeline program shows a significant difference from the other strategy choices.

Table 7: Frequency of participation in outreach events for the MLS profession

Strategy	Total Respondents	Frequency
Presentations at career fairs	59	73.75%
Giving lab tours to middle/high school students	52	65.00%
Affiliation with a STEM pipeline program	27	33.75%
Participating in "career day" at middle/high schools	43	53.75%
I do not participate in any outreach events	7	8.75%

Barriers to Graduating

Program directors were asked about barriers they encounter that hinder students from graduating (see Table 8 and Table 9). The most frequently answered barrier was

"students unable to handle the academic rigors of program" (70.7%) (Cochran's $Q=65.55$, $p<0.0001$). This was followed by "student stress from other factors in the program" (62.7%), "adequate availability of clinical sites" (49.3%), and "locating and/or recruiting qualified instructors" (42.7%) (see Table 8). "Lack of resources/laboratory space for instruction" had a frequency of 26.7% and "budgeting and funding the program" had a frequency of 16.0%. The null hypothesis was rejected and post-hoc multiple pairwise comparisons were done to determine the significant differences between each barrier. There was no significant difference between "students unable to handle academic rigors of the program" and "students stress from factors in the program". "Students unable to handle academic rigors" did show a significant difference from "budgeting and funding", and "locating/recruiting qualified instructors" and "lack of resources/laboratory space". "Student stress from factors in the program" showed a significant difference from "budgeting and funding the program" and "lack of resources/laboratory space".

Table 8: Barriers to student retention in MLS programs

Barrier	Total Respondents	Frequency
Budgeting and funding the program	12	16.00%
Adequate availability of clinical sites	37	49.33%
Locating and/or recruiting qualified instructors	32	42.67%
Lack of resources/laboratory space for instruction	20	26.67%
Students unable to handle the academic rigors of program	53	70.67%
Student stress from factors in the program (i.e. time commitment, tuition payment, etc.)	47	62.67%

Participants were specifically asked about reasons why students do not graduate from their program. The program directors answered "student dismissed due to poor grades" (75.7%), "personal stress affecting performance" (47.1%), "too demanding of a class schedule" (40.0%), "change majors" (37.0%), and "dismissal due to professional concerns" (10.0%) (Cochran's $Q=59.02$, $p<0.0001$) (see Table 9). Multiple pairwise comparisons were done to determine which barriers were responsible for the significant difference. Student dismissal due to poor grades showed a significant difference from all other answer choices.

Table 9: Barriers MLS programs encounter with students successfully graduating

Barrier	Total Respondents	Frequency
Student dismissed due to poor grades	53	82%
Personal stress affecting performance	33	51%
Dismissal due to professional concerns	7	11%
Too demanding of a class schedule	28	43%
Change majors	21	32%

Respondents reported that 42% have difficulty in securing clinical sites whereas 56% do not experience any difficulty. Most programs (95%) had clinical sites secured by program staff, but there were a few programs that required their students to find their own clinical sites (3%). Out of the two programs who require students to secure their own clinical rotation sites, one reported that their students have expressed apprehension about this task. The other director was unsure if students experience apprehension about being required to secure their own clinical sites. Of the program directors surveyed, 98% responded that facilities do not agree to host students for clinicals due to a lack of staff to train them (Cochran's $Q=199.551$, $p<0.0001$). Other reasons cited for not hosting students were implementation of new instrumentation/Laboratory Information Systems (14%), and competition with other MLS/MLT programs (15%) (see Table 10).

Table 10: Reasons laboratory administration does not agree to host students for clinical rotations

Barrier	Total Respondents	Frequency
Not enough staff to train students	58	98%
Reputation of the program	1	2%
Issues with an individual student	5	8%
New instrumentation/LIS implementation	8	14%
Competition with other MLS/MLT programs	9	15%
No adequate department (BB/micro)	3	5%

Program directors were asked which strategies they have used to increase their class size (see Table 11). The most common strategy used was to seek out additional

clinical sites (61.4% of respondents) (Cochran's Q=84.929, p<0.0001). Frequencies for the other answer choices were "utilize online coursework" (30.0%), "increase available space in classroom for instruction" (11.4%), "provide incentives to clinical instructors/affiliate laboratories" (7.1%), and "provide incentives for your program instructors" (2.9%). On the other hand, 27% of program directors did not want to increase their class size. Further analysis with multiple pairwise comparisons was done and determined that seeking additional clinical affiliates was significantly different from other strategies.

Table 11: Strategies used to increase class size in MLS programs

Strategy	Total Respondents	Frequency
Seek out additional affiliates for clinical rotations	43	61%
Provide incentives to clinical instructors/affiliate laboratories	5	7%
Provide incentives to your program instructors	2	3%
Increase available space in classroom for instruction	8	11%
Utilize online coursework	21	30%
I do not want to increase my class size	19	27%

There were 39% of program directors who stated that they use online classes in their curriculum and 32% of program directors who do not use online coursework. More interestingly, however, were the 28% of program directors who stated that they currently do not utilize online classwork, but they have considered it. However, it seems that of those who do use online coursework, 45% of participants do not think it provides any

attractive feature to students. When asked if program directors utilize sponsorships at their MLS program, 67% of program directors said “no”, 25% said “yes”, and 8% said “no but it has been considered”. Sponsorships were defined for participants as students earning a scholarship from a clinical site, and in return, must work for the clinical site for a specified amount of time after graduating from school. Of those programs that do participate in sponsorships, 45% feel the sponsorships provide a kind of incentive for students to enter their program.

Retention in the Workforce

The researcher wanted to ask program directors if there is any relationship between where new graduates obtain employment and how close that job is to their former clinical rotation sites. Not surprisingly, 66% of program directors said that at least half of their new graduates obtained employment at one of their clinical sites. A large number of program directors (81%) said that graduates obtain employment less than 50 miles from their clinical sites. Additionally, the vast majority (92%) of new graduates obtained a job in less than 3 months after graduation.

The program directors were asked to rank their top 3 choices for strategies that would be most helpful in decreasing the MLS workforce shortage (see Table 12). The highest ranked strategy was more advancement opportunities in the laboratory (average rank = 1.7). “More MLS programs” was slightly lower with an average rank of 1.8. “Providing ‘bridge’ programs for MLTs to become MLS” had an average rank of 2.0, and “allowing for ‘on-the-job’ training for non-MLS science majors” had an average rank of 2.1. The Skillings-Mack test resulted in $Q = 3.451$ and $p=0.327 > 0.05$.

Table 12: Most impactful strategies to decrease the MLS workforce shortage

Strategies	Total Respondents	Average Rank	Frequency
More advancement opportunities within the laboratory	63	1.7	81%
More MLS programs	55	1.8	71%
Providing "bridge" programs for MLTs to become MLS	53	2.0	68%
Allowing for "on-the-job" training for non-MLS science majors	20	2.1	26%

Lastly, participants were asked what they felt were the largest contributors to the medical laboratory science workforce shortage (see Table 13). A lack of recognition as a profession had the highest average rank at 1.5, and salary differences between other healthcare fields had an average rank of 1.9. Students aspiring to continue their career to other healthcare fields had an average rank of 2.4. Not enough MLS programs, lack of advanced career opportunities, and decreased interest in science-related majors had average ranks of 2.3, 2.9, and 3.4 respectively. A Skillings-Mack test was applied, $Q = 41.170$ and $p<0.0001$. Post-hoc multiple pairwise comparisons were run to determine which barriers were significant compared to one another. Lack of recognition as a profession showed a significant difference from salary differences, lack of advanced career opportunities, and students having other aspirations of continuing onto other healthcare fields. Students having aspirations of continuing onto other healthcare fields showed a significant difference from lack of recognition as a profession, and salary differences between other healthcare fields.

Table 13: Most significant contributing factors to the MLS workforce shortage

Barrier	Total Respondents	Avg Rank	Frequency
Lack of recognition as a profession	70	1.5	89%
Salary differences between other healthcare fields	67	1.9	85%
Not enough MLS programs	22	2.0	28%
Lack of advanced career opportunities	22	2.7	28%
Decreased interest in science-related majors	7	2.7	9%
Students have aspirations of continuing onto other healthcare fields	47	2.4	59%

CHAPTER V

DISCUSSION

The purpose of this study was to identify barriers that MLS programs encounter in student recruitment and retention in their programs. Along with barriers, this study aimed to identify any strategies that the MLS programs use to overcome those barriers. Additionally, this study wanted to collect the opinions of program directors on the MLS workforce shortage.

Student Recruitment

Overall, program directors who were surveyed reported that there are less students applying to their MLS programs. The program directors who were surveyed reported that 37% of them have seen a decrease in the number of applicants over the past 5 years, whereas only 29% of program directors have seen an increase in the number of applicants. When asked to quantify this change, 62% of respondents said that they have seen less than a 50% change in applicant pool size. These results show that there are less students applying to MLS programs. However, these results seem contradictory to NAACLS' annual survey of programs that reports the number of graduates has increased over the past 15 years (Cearlock & Swartz, 2018). The numbers stated in the NAACLS report could be increased due to MLTs furthering their education and obtaining their MLS rather than new graduates entering into the field for the first time (A. S. o. C. L. Science, 2018).

According to the program directors surveyed, the fact that students are unaware of this profession is the most significant limiting factor to recruiting qualified students ($Q=127.59$, $p<0.0001$). This is not surprising considering that laboratory scientists are hardly ever seen by the public (Kaplan & Burgess, 2010; A. S. o. C. L. Science, 2018). In fact, most students who know about medical laboratory science before they enter college are aware of the profession because of a family member or friend who works in the clinical laboratory (Stuart, 2002). Therefore, public knowledge of this profession is a major hurdle to overcome (Bennett et al., 2014; Renfro, 2015; A. S. o. C. L. Science, 2018).

Since public visibility is a major problem for the profession, participants were asked what strategies they use to recruit students to their programs. About 90% of program directors answered that they collaborate with academic advisors to aid in student recruitment. The second most frequently stated strategy was the use of pamphlets/flyers posted around their institution/affiliated organizations, and the third most popular strategy was participating in career fair presentations. The multiple pairwise comparisons tested post-hoc to Cochran's Q showed no significant difference between these three strategies. Therefore, all three strategies are utilized equally amongst respondents.

To quantify how useful these strategies are to program directors, they were asked to rank their top 3 choices with 1 being the most important and 3 being the least important. Collaboration with academic advisors had the highest rank of 1.4, career presentations ranked 2.1, and pamphlets/flyers was ranked 3.0. So, while program

directors utilize all three strategies equally, they consider collaborating with academic advisors the most helpful. College advisors have direct contact with prospective students and are in the perfect position to inform students about the clinical laboratory profession. Next to relatives and family friends, students obtain information about the MLS profession from their college advisors (Stuart, 2002). Based upon these findings, MLS programs should make it a priority to develop strong relationships with biology and/or pre-med university advisors to aid them in student recruitment.

Posting pamphlets and flyers around an institution is one of the simplest strategies for programs to provide information to a large group of people, however, it is a passive strategy. Providing career presentations for interested students is a more effective way to have face-to-face interactions with students and to promote the MLS profession actively. Students can ask questions about the field and/or the specific program, and program directors can meet potential applicants.

All of the previously stated strategies are utilized to attract students already attending college/university. The MLS profession also needs to focus its recruitment strategies on high-school and middle school students. The current strategies program directors are using to promote the profession at outreach events include career presentations, giving lab tours to students, and participating in career day at middle/high schools. The idea with outreach strategies is that if younger students know about this profession, then they may be more likely to choose it as their college major as freshman rather than finding out about the profession late in their college years (Wisecarver, 2018). An effective way for MLS programs to participate in outreach events is by

giving lab tours to younger students. These tours are a brief yet tangible first glimpse for young students to see how a clinical laboratory operates (Irizarry-Barreto, Coletta, & Scott, 2018). All of these strategies are useful in the long term because many high school students already have an idea what they want to study before they reach college (Haun et al., 2005). Therefore, if high school students go into college already knowing about MLS as a profession, they will be more likely to enter a program and/or appropriate degree plan.

The survey asked program directors about their utilization of STEM pipeline programs to recruit students to their program. STEM pipeline programs are used in high schools as an avenue for students to experience STEM fields beyond what they would encounter in a typical high school curriculum. Participation in STEM programs or events as younger students has been shown to support STEM interest and degree completion into college and post-baccalaureate degrees (Rodenbusch, Hernandez, Simmons, & Dolan, 2016; VanMeter-Adams, Frankenfeld, Bases, Espina, & Liotta, 2014). There are not many MLS programs that are currently utilizing pipeline programs with high-school aged students. This strategy is still a new concept in education, but one worth exploring, particularly in rural regions that are desperate for qualified laboratory scientists (Crump et. al, 2014; Flores, 2010).

Retention within MLS Programs

The second research question this study aimed to address was to identify barriers that programs experience in keeping students in their program and graduating them successfully. The primary barrier that impedes students from graduating from MLS

programs is students' inability to handle the academic rigors of the program. There was no data collected about the length of the programs in this survey, but MLS programs range from 12 months to 36 months in length (Brown et al., 2019; Scanlan, 2013). This is a relatively short amount of time to educate students over a large amount of complex material (Scanlan, 2013).

If students are unable to handle these academic rigors, programs may have to think critically about their approaches to learning and teaching their students. This may include restructuring the curriculum or utilizing various teaching strategies to deepen student understanding of the material. Programs can also focus on their admissions process to ensure that the students who are admitted into the MLS program can handle its academic rigors (Conway-Klaassen, 2016).

Since many students are paying for their own education and frequently have jobs outside of school, perhaps using online coursework would allow for flexibility in the students' schedule (Nasr & Jackson-Harris, 2016). However, the programs that stated in the survey that they do use online coursework were split in their opinions about whether the online courses served as any kind of recruitment draw for students. Additional studies should be performed from both faculty and student perspectives to determine if and/or how online courses effect student learning within MLS programs.

It is important to remember that it is the program directors who were reporting that students are struggling academically, and therefore unable to graduate. With an average of 20 students per class, the program directors are likely already aware of any students that are struggling in the program. There were 44% of program directors who

stated that students experience personal stress that affects their performance in the program. The survey in this project did not investigate what those factors are, but further exploration in this area would be beneficial. Stress from the academic rigor or the program will affect a student differently than stress from going through a divorce or another personal issue. Depending upon which stress factors are most reported, solutions and changes could be developed to better support students as they go through their MLS program.

Another common barrier to student retention that has been stated at times in the literature is the lack of available clinical sites for their student rotations (Renfro, 2015; A. S. o. C. L. Science, 2018). There were 32 (42%) program directors who said that they have trouble in securing clinical sites for their students. Despite having issues securing clinical sites, when asked which strategies program directors have used to increase class size, the most common response was to seek out additional affiliates for clinical rotations. This strategy showed a significant difference from other strategies in the survey (incentives for instructors, online coursework, increase in class space). The clinical rotation component is an essential piece of MLS education and serves to ensure that each new graduate can complete the minimum competency standard of a new employee (Scanlan, 2013). It is often the first time that students experience the day-to-day workflow of the clinical laboratory. The program directors in this survey reported that many clinical laboratories no longer host students or have refused to take any additional students because they do not have enough staff to complete both the clinical

laboratory work and train students. But if students cannot complete their clinical rotations, then they cannot graduate and begin working in the clinical laboratory.

There is also a problem with locating and recruiting qualified instructors. As with the MLS workforce, instructors (including program directors) are an older population that are beginning to retire (Cearlock & Swartz, 2018). Depending on the program type (university-based or hospital-based) the educational requirements for instructors may vary and therefore exclude applicants who otherwise would be interested in teaching. While finding instructors was not listed in the top three barriers for successfully graduating students, it is an important barrier because if there are no instructors to teach the students, then the medical laboratory science profession will not be able to increase the number of new graduates. One avenue of recruiting instructors would be to start with the laboratory scientists who work with students during their clinical rotations. These individuals most likely have some interest in teaching and could make the transition from bench work to teaching full-time.

Workforce Retention

Considering how many job vacancies there are in clinical laboratories, it was not surprising to find that new graduates are able to obtain employment within three months of graduating. In fact, it would not be surprising if many of those graduates had a job waiting for them while they were still in school. Not only are students becoming quickly employed, many students accept jobs at their clinical rotation sites. This further establishes the important and beneficial relationship between clinical laboratories and MLS programs. Laboratory staff can observe a student's skills closely, and often, in

multiple departments depending on the student's clinical rotation schedule. However, teaching students is time intensive, and when most labs are already understaffed, the additional responsibility of training a student can overwhelm staff.

There have been multiple strategies put forth regarding what can be done to decrease the workforce shortage from the perspectives of employers. This study sought to define what MLS program directors' thought would help to decrease the overall shortage. The three most frequent strategies put forth by the program directors are "more advancement opportunities within the laboratory", "more MLS programs", and "providing bridge programs for MLTs to become MLS".

As it stands, many laboratories have few supervisory roles that individuals can move into in a management capacity. Therefore, one could perceive the laboratory as a stagnant profession where one does not advance far throughout a career. By allowing for more advancement opportunities, possibly through a tiered structure among those who work directly at the bench level, medical laboratory science could become a more desirable profession (Swails, 2017). A professional ladder could also accompany a pay scale, so that employees would have financial incentives and extra job duties such as new employee training, designated instrumentation duties, etc. (Ali et al., 2012; Amerson et al., 2012). Providing bridge programs for MLTs to become MLS falls under the idea of advancement opportunities within the laboratory. While it does not directly increase the overall number of laboratory scientists, it creates an attainable goal for those interested. This continuing education could be incorporated into the professional ladder within an organization (Swails, 2017).

The idea that more MLS programs would be helpful in decreasing the workforce shortage is self-explanatory. The closure of many programs is part of the reason why there is a workforce shortage in the first place. If there are more programs open and available, then there are more students who can graduate every year. Over the past 10 years, there have been around 230 NAACCLS-accredited programs in the U.S (Cearlock & Swartz, 2018). That is about a quarter of the number of programs that existed in the 1990s. In order to increase the number of MLS programs, it will take a very concerted effort between universities and laboratory affiliates (Hammerling & van der Heyden, 2011). But if more MLS programs are able to open and graduate students, not only will overall numbers of laboratory professionals increase, but more regions—particularly rural regions—will have a more consistent influx of employee applicants (Giraldi, Garcia, Kundu, & Famitangco, 2018).

Overall, participants responded that the largest contributors to the MLS workforce shortage are lack of recognition as a profession, pay disparity compared to other healthcare fields, and student aspirations of continuing onto other healthcare fields. As stated earlier, programs often have issues with student recruitment because students do not know that the profession exists in the first place. Increasing public knowledge about medical laboratory science is a major hurdle to jump over but it is essential to increase the visibility of the MLS profession. It takes a coordinated effort between MLS programs, academic advisors, and professional organizations to increase public awareness of medical laboratory science as a profession and career option in healthcare.

While student's aspirations to move to other areas of healthcare does remove talent from the MLS profession, it is also beneficial in that the individual can rely upon their laboratory background and apply to their current work. Additionally, having individuals who have experience in the laboratory but move onto other healthcare fields creates opportunities for conversations to promote the MLS profession (Swails, 2017).

The pay disparity between the MLS profession and other healthcare fields that require similar (or less) education is certainly a deterrent to students being attracted to the profession. If a student were to research the medical laboratory science profession, it would be disheartening to see the average wage for MLS, and then compare it to other healthcare fields that have the same amount of education or even less education (i.e. nursing). It is a common complaint amongst employees working in the clinical laboratory (Garcia, Kundu, & Fong, 2018). While ensuring decent wages is an important issue in the laboratory profession, there is not a whole lot of influence that MLS programs themselves have regarding wages. The issue of pay disparity is a very complicated one, however, the overall pay rates are increasing for medical laboratory scientists (Garcia, Kundu, & Fong, 2018).

Limitations

The time of year that this study was conducted (mid-summer) could have decreased the response rate, as program directors could have been out of contact from their work email for personal reasons. However, the number of hospital-based program directors and university-based program directors who responded was similar to the percentages seen in the nationwide MLS program population. The low response rate

does limit the ability to make broad generalizations about the entire population of MLS programs, but the barriers experienced and potential solutions outlined in this study are helpful insights. There were no incentives provided to program directors to take part in this survey, and this could have contributed to less participants answering the survey questions. Additionally, this study only surveyed MLS programs and the results were applied within the context of MLS programs. These results do not necessarily apply to barriers or strategies encountered by MLT programs.

One limitation of this study is the low reliability calculated with Cronbach's alpha. The questions and the answer choices may not have fully correlated to the content intended. The combination of questions used to calculate Cronbach's alpha (check all that apply, multiple choice, etc.) may have contributed to the low reliability. Directors were also limited in their answer responses due to the lack of free text options.

Areas of Further Research

This study provides the foundation to bridge the literature gap about barriers MLS programs experience in student recruitment and retention, and what strategies they use to overcome those barriers. A similar survey could be applied to MLT programs, as well. While the profession is similar to MLS, the student population in an MLT program may have a different set of barriers regarding recruitment and retention. Another area of further study would be to research how rural programs are recruiting students. There was only one program director who identified as living in a rural area and, therefore, a focused analysis of rural programs was not able to be performed for this study. As noted previously, rural communities are chronically underserved in terms of healthcare, and

the clinical laboratory is no exception. Identifying what strategies are used to increase student enrollment in rural MLS programs could help further increase the number of students entering the profession. This could extent to the use of STEM pipeline programs and the affect in decreasing the workforce shortage in rural areas.

Lastly, an important area of further focus is additional research is the aspect of student stress and its contributing factor to students not graduating from their MLS program. Different causes of stress will require different solutions, and it would be beneficial for those stressors, and their solutions, to be furthered studied. The idea of work-life balance is becoming increasingly important, particularly with younger workers. While the laboratory has always been a place of "the work will get done no matter what", preventing employee burnout is an essential priority.

CHAPTER VI

CONCLUSIONS

As stated previously, clinical laboratories are experiencing a workforce shortage and some departments are expecting up to 20% of their staff to retire in the next 5 years (Garcia, Kundu, Ali, et al., 2018). The necessity of incoming graduates to fill job vacancies is not an unknown concept in the medical laboratory science profession. However, most of the literature approaches this problem from the perspective of managers and lab directors in terms of their employees. There has been very little research investigating what barriers MLS training programs experience and strategies they have used to help decrease the workforce shortage. This study aimed to identify barriers experienced in student recruitment and retention in MLS programs as well as strategies that are utilized to overcome those barriers.

Through a quantitative analysis of MLS program directors surveyed, it can be concluded that the primary barriers to student recruitment are students' lack of awareness of the profession and the salary differences between the clinical laboratory and other healthcare professions. For programs to increase the visibility and student knowledge of the MLS profession, program directors rely upon collaboration with academic advisors, flyers placed around their institution, and participating in career fair presentations. The primary obstacle that MLS programs face with retaining students in their program is students' inability to handle the academic rigors of the program. This challenge ultimately leads to student dismissal from the program due to poor grades.

From this study's findings, MLS programs can use this information to improve their recruitment techniques and also to retain students who enter into their program. Increasing student awareness of MLS careers will hopefully result in more students enrolling in degree programs in this field. Through additional systems designed to support students academically, MLS programs can help students to succeed in their education so they can successfully graduate. More graduates of MLS programs mean more qualified professionals to serve the medical community.

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APPENDIX A

SURVEY INSTRUMENT

Please provide the following information about your program:

1. Do you consent to participating in the following survey?
    - I agree
    - I disagree
2. Where is your program located?
    - Rural Area (<2,500 population, or not within an urban area)
    - Urban Cluster (2,500-50,000 population)
    - Urbanized Area (>50,000 population)
3. Are you the director of a hospital-based program or university-based program?
    - Hospital-based program
    - University-based program
4. On average, how many applicants apply to your program each year?
   _____
5. How many applicants are accepted into your program each year?
   _____
6. What is your graduating class size per year?
   _____
7. What is the passing rate of graduates from the Board of Certification examination (by AMT, ASCP, ABB, etc.) from your program over the past 5 years?
   _____

The following section pertains to strategies and barriers seen in student recruitment:

8. Has there been a change in the number of applicants to your program over the past 5 years?
    - Increase
    - Decrease
    - No change
9. If you have seen a change, approximately how much of a change?
    - <25%
    - 26-50%
    - 51-75%
    - >76%
    - No change seen
10. What do you feel are current limiting factors in recruiting qualified students to your program? (Check all that apply)
    - Students are unaware of Medical Laboratory Science as a career
    - Difference in wages compared to other healthcare fields
    - Lack of program flexibility (i.e. online coursework)
    - Lack of upward mobility on the professional ladder

- Cost of program tuition

11. Describe how you recruit students to your program (check all that apply)?
    - Pamphlets/Flyers around your institution/affiliates
    - Career Fair Presentations
    - Collaboration with academic advisors
    - Utilization of pipeline programs with high school-aged students
12. Of the recruitment strategies chosen in the previous question, which do you most heavily rely upon? (Rank Top 3 Choices)
    - Pamphlets/Flyers around your institution/affiliates
    - Career Fair Presentations
    - Collaboration with academic advisors
    - Utilization of pipeline programs with high school-aged students
13. Do you participate in any of the following outreach programs/events to promote the MLS profession? (Check all that apply)
    - Presentations at career fairs
    - Giving lab tours to middle/high school students
    - Affiliation with a STEM pipeline program
    - Participating in "career day" at middle/high schools
    - I do not participate in any outreach events

The following section pertains to issues and/or barriers within the MLS program in graduating students:

14. What do you feel are current program barriers to successfully graduating students? (Check all that apply)
    - Budgeting and funding the program
    - Adequate availability of clinical sites
    - Locating and/or retaining qualified instructors
    - Lack of resources/laboratory space for course instruction
    - Students unable to handle academic rigors of program
    - Student stress from factors in the program (i.e. time commitment, tuition payment, etc.)
15. What are some reasons why students do not graduate from your program? (Check all that apply)
    - Student dismissed due to poor grades
    - Personal stress affecting performance
    - Dismissal for professionalism concerns
    - Too demanding of a class schedule
    - Change majors
16. Are students or program staff responsible for obtaining clinical sites?
    - Students
    - Program staff
17. Has your program experienced difficulties securing a clinical site to complete the program?
    - Yes
    - No

18. Have students in the past expressed apprehension about being responsible for obtaining clinical sites when applying to your program? *[This question will only show up if respondents said "Students" to #15]*
    - Yes
    - No
    - Unsure
19. Are facilities/sites reluctant to train students or take on more students for their clinical rotations?
    - Yes
    - No
20. What reasons does lab administration give for not agreeing to host students for clinical rotations? (Check all that apply) *[This question will only show if respondents said "Yes" to #18]*
    - Not enough staff to train students
    - Reputation of the program
    - Issues with an individual student
    - Other (please specify): _____
21. Have you used any of the following to increase your class size? (Check all that apply)
    - Seek out additional affiliates for clinical rotations
    - Provide incentives to clinical instructors/affiliate laboratories
    - Provide incentives to your program instructors
    - Increase available space in classroom for instruction
    - Utilize online coursework
    - I do not want to increase my class size
22. Does your program utilize online classes as a part of your curriculum?
    - Yes
    - No
    - No, but it has been considered
23. If yes, do these online portions seem to be an attractant for students to apply to your program?
    - Yes
    - No
24. Does your program participate in sponsorships for students? [Sponsorship: students earn a scholarship from a clinical site and in return must work for the clinical site for a specified time.]
    - Yes
    - No
    - No, but we have considered utilizing sponsorships
25. If yes, has the sponsorship created an incentive for students to enter your program?
    - Yes
    - No

The following questions ask about students in the workforce after graduation:

26. On average, how quickly do students obtain employment after graduation?
    - 0-3 months
    - 3-6 months
    - >6 months
27. How close to their clinical sites do graduates usually obtain their employment?
    - <50 miles
    - 51-100 miles
    - >100 miles
28. On average, what percentage of graduates obtain employment at one of their clinical sites?
    - <25%
    - 26-50%
    - 51-75%
    - >76%
29. Of the following, which do you think would be most helpful in decreasing the medical laboratory science workforce shortage in the U.S? (Rank Top 3 choices)
    - More advancement opportunities within the laboratory
    - More MLS programs
    - Providing "bridge" programs for MLTs to become MLS
    - Allowing for "on-the-job" training to non-MLS science majors
30. What do you think are the largest contributors to the medical laboratory science workforce shortage in the U.S? (Rank Top 3 Choices)
    - Lack of recognition as a profession
    - Salary differences between other healthcare fields
    - Not enough MLS programs
    - Lack of advanced career opportunities
    - Decreased interest in science-related majors
    - Students have aspirations of continuing onto other healthcare fields

APPENDIX B

INSTITUTIONAL REVIEW BOARD DETERMINATION LETTER

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

EXEMPTION DETERMINATION
(Common Rule –Effective January, 2018)

July 01, 2019

Type of Review:	Submission Response for Initial Review Submission Form
Title:	When the Well Runs Dry: How to Survive the Medical Laboratory Science Drought
Investigator:	Emily Wilson
IRB ID:	IRB2019-0557M
Reference Number:	092905
Funding:	Internal
Documents Reviewed:	• MLSProgramSurvey_ConsentScript1.1 - (Version 1.1) • Gutberlet_ThesisProject_RecruitmentDocuments1 - (Version 1.1) • Gutberlet_Survey_3.27.2019 - (Version 1.0)
Review Category	Category 2: Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: i. The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; ii. Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.

Dear Emily Wilson:

The HRPP determined on 07/01/2019 that this research meets the criteria for Exemption in accordance with 45 CFR 46.101(b).

This determination applies only to the activities described in this IRB submission and does not apply should any changes be made. If changes are made you must immediately contact the IRB. You may be required to submit a new request to the IRB.

Your exemption is good for three (3) years from the Approval Start Date. Thirty days prior to that time, you will be sent an Administrative Check-In Notice to provide an update on the status of your study.

750 Agronomy Road, Suite 2701
1186 TAMU
College Station, TX 77843-1186

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http://rcb.tamu.edu

If you have any questions, please contact the IRB Administrative Office at 1-979-458-4067, toll free at 1-855-795-8636.

Sincerely,
IRB Administration