Effects of mentorship using surgical simulation for economically disadvantaged high school students

Byron D. Hughes, MD, MPH
University of Texas Medical Branch, Galveston, TX

Samuel H. Cass, MD
University of Texas Medical Branch, Galveston, TX

Hamza Uddin, BS
University of Texas Medical Branch, Galveston, TX

Taylor P. Williams, MD
University of Texas Medical Branch, Galveston, TX

Ikenna C. Okereke, MD
University of Texas Medical Branch, Galveston, TX

ABSTRACT

Underrepresented minority (URM) and economically disadvantaged (ED) high school students are less likely to graduate from high school or enroll in college. This institution began a structured mentorship program focusing on URM and ED students using a surgical simulation lab. The objective was to determine the effect of the mentorship program on students' pursuit of formal education after high school and perception of their ability to succeed in medicine.

Methods

Students were given lectures by one attending surgeon regarding college admission requirements, overcoming socioeconomic and cultural obstacles and sources of funding for college. Thereafter, students were brought to the surgical simulation laboratory to participate in basic surgical skills. Anonymous surveys were completed before and after participation to gauge the level of self-confidence and likelihood of applying for college. Participation was voluntary.

Results

Thirty-two students participated in the program. Seventy-five percent (24/32) were female. Sixty-six percent (21/32) were Latino/Hispanic and 34% (11/32) were Black/African-American. Upon completion of the program the average survey score increased significantly for having a major chosen for college ($p = 0.009$), feeling more prepared for the academic obligations of college ($p < 0.001$) and being interested in a career as a surgeon ($p < 0.001$).

Conclusion

Mentorship for high-risk students encourages pursuit of post-secondary education. Exposure to surgical simulation can raise a student's interest in a surgical career. Longitudinal studies are needed to determine the effects of coupling mentorship and interactive surgical simulation on high school graduation rates and the probability of obtaining a bachelor's degree.

Keywords: Mentorship, Economically Disadvantaged Students, Simulation, Surgery, Underrepresented

INTRODUCTION

Despite numerous initiatives, there continues to be a lack of diversity in the United States professional workforce.[1, 2] Although there are numerous factors which create this disparity, the lower college enrollment rate among underrepresented minority (URM) and economically disadvantaged (ED) high school students plays a major role. URM and ED students have been shown to be less likely to graduate with a baccalaureate degree.[3] And these students are less likely to become involved in science and engineering programs.[4] Programs designed to improve diversity have often targeted college students or those individuals already in the workforce.[5, 6] Although there are some programs designed for high school students, the literature evaluating the efficacy of these programs is limited.[7, 8]

Surgical simulation laboratories are becoming increasingly vital in the training of the surgical resident. Some of the attractive features of simulation labs are the hands-on nature of the training modules, the ability for trainees to perform surgical maneuvers in a relaxed environment and the visual nature of many of the simulation activities.[9] This type of environment is seemingly ideal for high school students, who are likely to react positively to a visual and stress-free atmosphere.[10, 11] Moreover, simulation-based programs have been shown to increase a trainee's self-reported motivation, interest in learning and confidence level.[12, 13] However, there is no available research that highlights the effect of coupling surgeon faculty instruction with simulation-based training for economically disadvantaged high school students.

To address this inequity, this institution began a mentorship program in which students participated in a structured career mentoring program. Additionally, students participated in lecture sessions and a surgical simulation laboratory taught by one URM attending surgeon. Our goal was to determine whether the mentorship program affected the likelihood that these students would pursue formal education after high school.

METHODS

Study Design

High school students from ED high schools in urban environments were invited to participate in the longitudinal mentoring program. The students were given multiple lectures by one attending surgeon regarding college admission requirement strategies to overcome potential socioeconomic and cultural obstacles and sources of funding for college tuition. Thereafter, the students were brought to the department of surgery's simulation laboratory on a Saturday for surgical simulation tasks and mentoring by the surgeon, surgical residents and medical students (Figure 1 - Appendix). Surgical residents and medical students aided in teaching basic surgical skills such as knot-tying, suturing, and laparoscopic simulation exercises. Following the simulation session, the students were given a tour of the entire hospital.

Study Cohort and Outcomes

Students between 9th and 12th grades were invited to participate. During the weekend visit, the students were asked to complete anonymous surveys immediately before and after the session that assessed their level of self-confidence, interest in medicine and science and likelihood of attending a college or university after high school (Supplemental Figure 1 - Appendix). The questions concerning self-confidence, interest in medicine and likelihood of pursuing higher education were scored from 1 to 5. Additionally, socioeconomic data such as

parents' highest level of education, student's personal work history and current academic performance were assessed. At the end of the program, all students were eligible to apply for a summer internship tailored to their career interests.

Covariates

Demographic characteristics which were recorded included grade level, race/ethnicity, gender and household income. Race was classified as Hispanic/Latino, Black/African-American, White/Caucasian, Asian/Pacific Islander, Native American or Other.

Statistical Analysis

Descriptive statistics were utilized to analyze patient sociodemographic characteristics with chi-square and t-test for categorical and continuous variables, respectively. The study was approved by the University of Texas Medical Branch Institutional Review Board.

RESULTS

Demographics

A total of 32 high school students participated in our program (Table 1, Appendix). Seventy-five percent were female (24/32). The students all identified themselves as Hispanic/Latino (66%) or African-American (34%). The majority of annual household incomes, when reported, were less than $25,000 (53%). The highest level of education among most parents of the participants was a high school diploma or equivalent in 63% of cases. Of note, the majority of students who decided to participate had taken an advanced placement course (83%), and 47% of participating students had taken a college-level course (15/32).

Survey Results

Table 2 (Appendix) shows the results of the survey before and after the program. The desire of the students to attend college was high before participating in the program, and the program did not significantly increase their desire (4.66 vs. 4.68, $p = 0.66$). There was a significant increase, however, in their desire to go into medicine (3.91 vs. 4.19, $p = 0.02$), their belief that they were prepared for the academic obligations of college (3.97 vs. 4.44, $p < 0.01$) and their belief that they possessed the physical dexterity needed to become a surgeon someday (3.53 vs. 4.03, $p < 0.01$).

DISCUSSION

This study was performed to evaluate the effectiveness of our pilot program with ED and URM high school students. Unfortunately, there is still a wide racial and economic achievement gap in this country, and it was felt that targeting high school students would provide a blueprint to address this gap. This study was small, including only 32 students. But from this pilot program certain discoveries were able to be made about which students were most likely to benefit from this program. As participation in this program was entirely voluntary, the most motivated students were most likely to enroll. The desire for college did not increase significantly in our cohort, as most of these students had already taken advanced placement

courses in high school and were almost certainly going to go to college anyway. This phenomenon of selecting out the most motivated students raises an important question. When implementing a program such as this at an ED school, which students should be sought? Should the most motivated students, who are expected to have the biggest benefit, be targeted? Or should the lesser performing students, who may be most at risk of negative long-term consequences of difficulties during high school, be who are preferentially included in a program as this? Given that resources are limited and not every student can be included, there may be benefit in involving both the high and low performers. Adjuncts to the program may make it easier for lesser performing students to become involved and will be considered in future iterations of this program, which has been shown to encourage better grades, conduct and peer relations.[14]

Another goal of this pilot study was to see if ED and URM students would become more interested in pursuing a career in a science, technology, engineering and mathematics (STEM) related field. Although this study did not increase students' desire to go to college, the results did indicate that a mentorship program in the setting of a hands-on surgical simulation lab significantly increased a student's interest in pursuing careers in medicine and surgery after simulation. While sparking interest through career guidance is a critical step in the effort to change the landscape of the healthcare profession, it may not be enough to overcome the lack of access to the field. High schools in low-income areas often have fewer counselors equipped for health science advisement, fewer research opportunities, larger class sizes and less rigorous curricula.[15-16] This pilot program aimed to provide a solution for these educational shortcomings. An added benefit of a surgical simulation program is that it provides practical skills and field-related education that can give insight into the physical demands of being a surgeon. It was noteworthy to us that many of the students were unsure of their technical ability before the program. After participation in the program, confidence levels in dexterity and skills elevated significantly, a psychological effect (i.e. confidence), which has been demonstrated in numerous studies and youth training programs. [17-21] This increase in confidence highlights a common but adverse theme in ED high schools. Many of these students have tremendous potential but lack belief in their abilities. It is expected that programs like this one will make students more likely to realize their capabilities and aid recruitment of URM into surgical careers.

Surgical simulation labs are an ideal environment for high school students to learn. Although it is debatable whether the younger generations are more likely to be "visual learners" or have different attention spans than older people, it is undeniable that today's youth has grown up with more access and exposure to multimedia sources and technological advances not available previously. As such, the hand-eye coordination of younger people is probably more highly developed at an earlier age nowadays. Moreover, this early exposure to technology has proven to be an asset; multiple studies focused on laparoscopic skilling training in youth have demonstrated capability of high school aged students to complete laparoscopic skills courses, and also have demonstrated correlations between faster task completion and fewer errors with video game experience. [22-23] It was expected that participants would react favorably to a surgical simulation environment. The students did indeed have a very high satisfaction level with their experience, and it appears that surgical simulation labs are effective settings for high school students to learn.

The most recognizable limitation to this study is likely the selection bias of students. The participants enrolled in the study may potentially have more academic successes than their peers and may have been more likely to have an interest in health sciences prior to matriculation into

the study. Nevertheless, the aim of this program was to nurture the development of talented and interested students from ED areas and give them a better opportunity to achieve their career ambitions. Secondly, this was a small cohort of only 32 students. However, the study was designed as a pilot and the plan is to expand our efforts based on these results. Finally, longitudinal follow-up will be required to determine the ultimate efficacy of this program. Development of similar programs nationwide will be critical to close the racial and economic achievement gap.

CONCLUSIONS

Mentorship using surgical simulation for ED and URM high school students increases confidence levels and desire to pursue a career in medicine. This outreach may also increase college enrollment rates at ED high schools, though further longitudinal analysis is needed. And the surgical simulation lab has ideal characteristics for the younger generations to learn and gain self-assurance in their capabilities and potential.

DECLARATIONS

Availability of supporting data
De-identified data of this study is available upon request.

Funding
There was no funding for this project.

Competing Interests
The authors declare that they have no competing interests.

Acknowledgements
None

Abbreviations
URM—Underrepresented minority
ED—Economically disadvantaged
STEM—Science, technology, education and mathematics

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APPENDIX

Figure 1—Students in the Surgical Simulation Laboratory

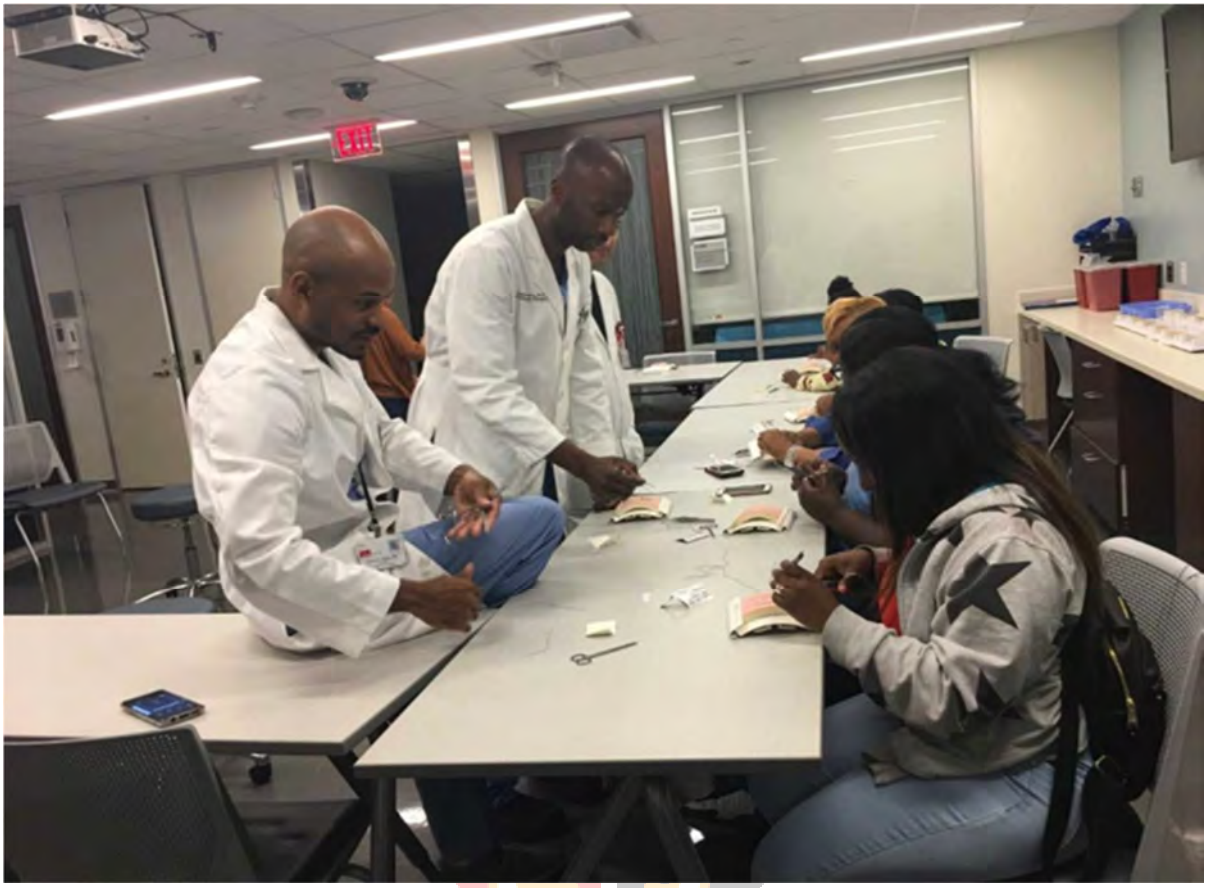

Table 1—Student Demographics

Demographics	
Gender	n=32
Male	8
Female	24
Race	n=32
Black/African-American	11
Hispanic/Latino	21
Parents Highest Level of Education	n=27
High School	20
2-year College/Associates Degree	1
4-year College/University Degree	5
Post-Graduate Degree	1
Estimate of Yearly Household Income	n=24
$0-24,999	9
$25,000-$49,999	8
$50,000-%75,000	7
High School Job and Weekly Hours Worked	n=32
No	22
Yes, 0-10 hours	1
Yes, 11-15 hours	4
Yes, 15+ hours	5
Number of Advanced Placement Courses	n=30
None	5
1	10
2	11
3+	4
Taken College Courses	n=30
Yes	14
No	16

Table 2—Survey Results

Survey Question	Before	After	p-value
Desire to go to college or university?	4.65625	4.6875	0.662
Desire to pursue a career in a science, technology, engineering or medicine?	4.25	4.46875	0.032
Desire to pursue a career in medicine?	3.90625	4.1875	0.018
Desire to pursue a career as a surgeon?	3.0625	3.71875	<0.001
“I am prepared for the academic obligations of college”?	3.96875	4.4375	<0.001
“I have the ability to one day become a surgeon”?	3.78125	4.09375	0.031
“I know what subject I would like to study in college”?	4.25	4.59375	0.009
“I have specific career goals”?	4.4375	4.6875	0.009
“I am confident that I will accomplish my career goals”?	4.625	4.78125	0.023
“I have the dexterity and physical ability required to become a surgeon one day”?	3.53125	4.03125	0.003

Supplemental Figure 1—Survey Questions

Pre- Survey

(Please circle one answer)

1. What is your gender

   A. Male
   B. Female

2. With which race do you identify?

   A. Hispanic/Latino
   B. Black/African American
   C. White/Caucasian
   D. Asian/Pacific Islander
   E. Native American
   F. Other

3. What is the highest level of education attained by your parent/parents?

   A. High School
   B. 2-year college/Associates Degree
   C. 4-year college/University Degree
   D. Post-Graduate Studies/Degree

4. Please estimate your family's household income:

   A. $0 – $24,999
   B. $25,000 – $49,999
   C. $50,000 – $74,999
   D. $75,000 – $99,999
   E. $100,000+

5. Do you work a job while attending high school? If yes, how many hours per week?

A. No

B. Yes, 5 hours or less

C. Yes, 5 – 10 hours

D. Yes, 10 – 15 hours

E. Yes, 15 hours+

6. Please indicate how many Advanced Placement (AP) courses you have taken by subject field:

_____ Math

_____ Biology

_____ Chemistry

_____ Physics

_____ Other

7. Have you taken any college courses for credit? If Yes, indicate number of hours:

A. No

B. Yes - _____ hours

8. Have you taken the SAT or ACT standardized examinations? If yes, please indicate your highest score:

A. No

B. SAT - _____

C. ACT - _____

Answer the following questions on a 1 – 5 scale, with 1 = very weak, 2 = somewhat weak, 3 = indifferent, 4 = somewhat strong, 5 = very strong.

9. What level of support and encouragement do you have from a parent or mentor to attend college or university?

1 2 3 4 5

10. What level of support and encouragement do you have from a parent or mentor to pursue a career in science, technology, engineering, or medicine?

1 2 3 4 5

11. What level is your desire to go to college or university?

1 2 3 4 5

12. What level is your desire to pursue a career in a science, technology, engineering or medicine?

1 2 3 4 5

13. What level is your desire to pursue a career in medicine?

1 2 3 4 5

14. What level is your desire to pursue a career as a surgeon?

1 2 3 4 5

15. How strongly do you agree with the statement: “I am prepared for the academic obligations of college”?

1 2 3 4 5

16. How strongly do you agree with the statement: “I have the ability to one day become a surgeon”?

1 2 3 4 5

17. How strongly do you agree with the statement: “I know what subject I would like to study in college”?

1 2 3 4 5

18. How strongly do you agree with the statement: “I have specific career goals”?

1 2 3 4 5

19. How strongly do you agree with the statement: “I am confident that I will accomplish my career goals”?

1 2 3 4 5

20. How strongly do you agree with the statement: “I have the dexterity and physical ability required to become a surgeon one day”?

1 2 3 4 5

Post- Survey

Answer the following questions on a 1 – 5 scale, with 1 = very weak, 2 = somewhat weak, 3 = indifferent, 4 = somewhat strong, 5 = very strong.

1. What level is your desire to go to college or university?

1 2 3 4 5

2. What level is your desire to pursue a career in a science, technology, engineering or medicine?

1 2 3 4 5

3. What level is your desire to pursue a career in medicine?

1 2 3 4 5

4. What level is your desire to pursue a career as a surgeon?

1 2 3 4 5

5. How strongly do you agree with the statement: “I am prepared for the academic obligations of college”?

1 2 3 4 5

6. How strongly do you agree with the statement: “I have the ability to one day become a surgeon”?

1 2 3 4 5

7. How strongly do you agree with the statement: “I know what subject I would like to study in college”?

1 2 3 4 5

8. How strongly do you agree with the statement: “I have specific career goals”?

1 2 3 4 5

9. How strongly do you agree with the statement: “I am confident that I will accomplish my career goals”?

1 2 3 4 5

10. How strongly do you agree with the statement: “I have the dexterity and physical ability required to become a surgeon one day”?

1 2 3 4 5