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Never too early: the impact of a shadowing programme in paediatric and congenital cardiac surgery for undergraduate college students

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Abstract

Purpose: Diversification of the medical and cardiothoracic surgical workforce represents an ongoing need. A congenital cardiac surgery shadowing programme for undergraduate students was implemented at the University of Florida Congenital Heart Center. **Methods:** Students shadowing in the Congenital Heart Center from 17 December 2020 through 20 July 2021 were sent a survey through Qualtrics to evaluate the impact of their shadowing experience. The main objectives of the survey were to determine the personal relationship(s) of the students to physicians prior to shadowing, how the presence or absence of physicians in the family of a given student related to the exposure of the student to a medical setting prior to shadowing, and the interest of the students in medicine and cardiothoracic surgery prior to and after the shadowing experience. Survey responses included “Yes/No” questions, scaled responses using a Likert scale, selection lists, and free text responses. When applicable, t-tests were utilised to assess differences between student groups. **Results:** Of the 37 students who shadowed during the study period, 26 (70%) responded. Most students were female (58%, $n = 15$), and the mean age was 20.9 ± 2.4 years. Students spent a mean duration of 95 ± 138 hours shadowing providers as part of the shadowing programme. Likert scale ratings of interest in the professions of medicine, surgery, and cardiothoracic surgery all increased after the shadowing experience ($p < 0.01$). Students with a family member in medicine had more clinical exposure prior to the shadowing programme ($p < 0.01$). **Conclusion:** A surgical shadowing programme at a Congenital Heart Center may have an important formative impact on the views of undergraduate students regarding potential careers in surgery and medicine. Additionally, students without family members in medicine tend to have less prior exposure to medicine and could likely benefit more from this type of shadowing programme.

It is the professional responsibility of cardiothoracic surgeons to both mentor and sponsor the next generation of cardiothoracic surgeons and simultaneously to ensure diversity in the field.¹ Part of this process is assuring that differences in opportunity never exist based on race, gender, or any other sociodemographic source of bias. The values of diversity, equity, and inclusion are fundamental to this process and must never be compromised. Such actions to minimise bias and promote inclusivity will ensure that cardiothoracic surgical care is provided by a workforce representative of the diversity of patients whom we serve.²

In the United States of America, the Integrated Cardiothoracic Surgery training pathway combines training in General Surgery and Cardiothoracic Surgery over 6 years. This cardiothoracic surgical training pathway was created, in part, to increase the workforce of cardiothoracic surgeons and increase interest in the field; however, disparities in applications and matriculants into the integrated programmes among women and minorities have highlighted a need to foster early interest in the specialty.³ While efforts to improve diversity among applicants have helped, disparities persist, especially among female applicants.^{4,5}

Shadowing is an important part of the education of a premedical undergraduate student to gain the insights required to be a well-rounded applicant, and shadowing is one of the criteria for selection to medical school.⁶ A congenital cardiac surgery shadowing programme for undergraduate students was implemented at University of Florida Congenital Heart Center. The purpose of this article is to report the results of a survey of undergraduate students who shadowed the cardiothoracic surgical programme at University of Florida Congenital Heart Center. The goal of this survey was to assess the impact of our shadowing programme by determining

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the personal relationship(s) of the students to physicians prior to shadowing, how the presence or absence of physicians in the family of a given student related to the exposure of the student to a medical setting prior to shadowing, and the interest of the students in medicine and cardiothoracic surgery prior to and after the shadowing experience.

Methods

Shadowing programme

In December 2020, a formal shadowing programme for undergraduate students interested in medicine was instituted at University of Florida Congenital Heart Center. To enhance diversity, an important goal of the programme is to recruit students underrepresented in medicine, through offering shadowing opportunities in the fields of congenital heart surgery, anaesthesiology, paediatric cardiology, and paediatric cardiac critical care. Students are recruited through presentations given at undergraduate medical organisation meetings. All students interested in shadowing are given the opportunity to be involved in the programme.

Students in the shadowing programme all:

- Attended rounds with the cardiac surgeons, cardiologists, and intensive care physicians in the Pediatric and Congenital Cardiac Intensive Care Unit,
- Observed the operations and procedures for the day or week, and
- Interacted with medical and surgical staff in the post-operative period.

Some students, when the opportunity arose, were allowed to participate in cardiac organ procurement. Student experiences varied somewhat based on the surgical schedule and the level of engagement of the student. Students were allowed to return to shadow as often as they desired.

Study description

A retrospective single-centre study was conducted by surveying students who participated in the shadowing programme at University of Florida Congenital Heart Center between 17 December 2020 and 20 July 2021. After Institutional Review Board approval, a 31-item Qualtrics survey was distributed to all students who participated in the shadowing programme during the study period. Survey responses included “Yes/No” questions, scaled responses using a 1- to 5-point Likert scale, selection lists, and free text responses. Although students younger than 18 years of age were allowed to participate in the shadowing programme, this study only includes those 18 years of age or older. Only complete survey responses were included.

Data collection

Contact information for students who participated in the shadowing programme was collected at the time of the shadowing experience. At the end of the study period, the Qualtrics survey was sent to all students who had shadowed during the study period. Baseline and demographic data included sex and age at the time of the first shadowing experience. Data were collected to delineate previous experiences of the students with or without ties to medicine and surgery, including whether they had a first-degree family member

in the medical field. Finally, questions were posed to evaluate the shadowing experiences of the students in our programme and the impact these experiences had on their interest in medicine, surgery, and cardiothoracic surgery, as well as changes in their level of interest in the medical school associated with our institution.

Primary outcomes

This study had two primary outcomes. The first primary outcome was to determine if our shadowing programme has any impact on student interest in medicine as a career and cardiothoracic surgery as a future specialty. The second primary outcome was to identify any difference in prior clinical exposure between students who possessed a physician relative or mentor and students who did not.

Statistical analysis

All answers to “Yes/No” and Likert scale questions were analysed via two sample paired t-tests for means and to assess significance. A p-value <0.05 was considered statistically significant.

Results

Study population

During the study period, 37 students participated in the shadowing programme and were sent a Qualtrics survey. The response rate was 70.2% (26/37). Respondents were 42.3% (n = 11) male, and mean age for the cohort was 20.9 ± 2.4 years at the time of the first shadowing experience. The mean time spent shadowing with the congenital heart surgeons at University of Florida Congenital Heart Center was 95 ± 137.6 hours.

Previous experiences and ties to medicine or surgery

Slightly more than one-third of participating students (38.5% [n = 10]) indicated they had a physician relative or physician mentor. Of the students who indicated they had a physician relative or mentor (n = 10), 80% (n = 8) reported extensive clinical exposure (>50 hours) prior to their shadowing experience, compared to 25% (n = 4) in the cohort of students without a physician relative or mentor (n = 16). All students with a physician relative or mentor reported some level of clinical exposure prior to shadowing, whereas 18.75% (n = 3) of students without a physician relative or mentor reported no prior clinical exposure. In total, students who responded saying they had a physician relative or physician mentor had more clinical exposure prior to their shadowing experience in our shadowing programme ($p < 0.01$), as documented in Table 1.

University of Florida congenital heart surgery shadowing experience

Interest in medicine, surgery, and cardiothoracic surgery all increased compared to interest in these fields prior to shadowing ($p < 0.01$), and this increase was greater in the female cohort.

Interest in the associated medical school increased significantly after participating in the shadowing programme ($p < 0.01$), although when analysed by sex, only female respondents showed an increase in interest in the associated medical school ($p < 0.01$).

When examining changes in interest based on previous clinical exposure, students without a physician relative or physician

Table 1. Respondent demographics, level of prior interaction in clinical environments, and changes in interest based on gender

Overall	n = 26	% or SD	p-value
Response rate	26/37	70.30%	
Age (years)	20.9	2.4	
Male	11	42.30%	
Female	15	57.70%	
Hours spent with CT department	95	137.6	
Students with physician relative or physician mentor	10	38.50%	<0.01
Extensive interaction (50+ hours)	8	80%	
Moderate interaction (20–50 hours)	1	10%	
Some interaction (1–20 hours)	1	10%	
None (0 hours)	0	0%	
Students with no physician relative or physician mentor	16	61.50%	
Extensive interaction (50+ hours)	4	25%	
Moderate interaction (20–50 hours)	4	25%	
Some interaction (1–20 hours)	5	31.25%	
None (0 hours)	3	18.75%	
Level of interest in CT prior to shadowing (1–5)	3.36	0.86	
Male	3.45	0.82	
Female	3.29	0.91	
Level of interest in CT after shadowing (1–5)	4.4	0.65	<0.01 Overall
Male	4.27	0.79	<0.05 Male
Female	4.5	0.52	<0.01 Female
Level of interest in associated medical school prior to shadowing (1–5)	3.68	1.18	
Male	4	1.1	
Female	3.43	1.22	
Level of interest in associated medical school after shadowing (1–5)	4.32	0.99	<0.01 Overall
Male	4.36	0.81	>0.05 Male
Female	4.29	1.14	<0.01 Female
Did shadowing experience increase desire to do well in classes? (1–5)	4.76	0.6	

CT=cardiothoracic surgery.
SD=standard deviation.

mentor had a greater increase in the level of interest in the associated medical school (0.20 ± 0.63 versus 0.93 ± 0.88 , $p = 0.034$) and had a greater interest in surgery as a career post-shadowing exposure (4.30 ± 0.82 versus 5.00 ± 0.0 , $p < 0.01$), as documented in Table 2. Importantly, baseline (prior to shadowing) interest in medicine, surgery, cardiothoracic surgery, and the associated medical school did not vary between those with and those without a physician relative or physician mentor.

When comparing those students with moderate or extensive prior shadowing exposure to those with little or no prior shadowing exposure, there was no difference at baseline, post-exposure, or in the change in level of interest between these two groups, as documented in Table 3.

Finally, the mean Likert scale rating for whether shadowing increased the desire of students to do well in their classes was 4.76 ± 0.6 out of 5.

Discussion

The lack of diversity among cardiothoracic surgical trainees – and specifically, the underrepresentation of minorities and women – continues to be a key challenge.^{3,4,5} Because the integrated pathway pushes the decision to become a cardiothoracic surgeon earlier in training, early and diverse exposure to cardiothoracic surgery is vital to promote a well-balanced workforce that is truly representative of the patients that we serve. We instituted our survey to assess the impact of our shadowing programme on interest in cardiothoracic surgery, as well as medicine as a whole.

Our study reveals two key conclusions. First, in our study, designing and implementing a cardiothoracic surgical shadowing programme resulted in a significant increase in the interest of the shadowing students in the field of cardiothoracic surgery, particularly among women ($p < 0.01$). Second, our study reveals that students with physician relatives or mentors entered our

Table 2. Impact of the shadowing programme on student interest among those with and without a physician relative or physician mentor

Variable	All respondents (n = 26)	Students with physician relative/mentor (n = 10)	Students without physician relative/mentor (n = 16)	p-value
Level of interest in medicine prior to shadowing (1–5)	4.72 ± 0.54	4.90 ± 0.32	4.60 ± 0.63	0.180
Level of interest in medicine after shadowing (1–5)	5.00 ± 0.0	5.00 ± 0.0	5.00 ± 0.0	NA ^a
Change in level of interest in medicine	0.28 ± 0.54	0.10 ± 0.32	0.40 ± 0.63	0.180
Level of interest in surgery prior to shadowing (1–5)	4.04 ± 0.89	3.80 ± 0.92	4.20 ± 0.86	0.280
Level of interest in surgery after shadowing (1–5)	4.72 ± 0.61	4.30 ± 0.82	5.00 ± 0.0	0.003
Change in level of interest in surgery	0.68 ± 0.75	0.50 ± 0.53	0.80 ± 0.86	0.337
Level of interest in CT prior to shadowing (1–5)	3.36 ± 0.86	3.10 ± 0.88	3.53 ± 0.83	0.225
Level of interest in CT after shadowing (1–5)	4.40 ± 0.65	4.10 ± 0.57	4.60 ± 0.63	0.056
Change in level of interest in CT	1.04 ± 0.89	1.00 ± 0.94	1.07 ± 0.88	0.859
Level of interest in associated medical school prior to shadowing (1–5)	3.68 ± 1.18	4.10 ± 1.29	3.40 ± 1.06	0.150
Level of interest in associated medical school after shadowing (1–5)	4.32 ± 0.99	4.30 ± 1.34	4.33 ± 0.72	0.936
Change in level of interest in associated medical school	0.64 ± 0.86	0.20 ± 0.63	0.93 ± 0.88	0.034

Values are mean ± SD unless otherwise indicated.

CT=cardiothoracic surgery.

^aCannot be computed because the standard deviations of both groups are zero.

Table 3. Impact of the shadowing programme on student interest among those with moderate or extensive shadowing experience versus those with no or some shadowing experience

Variable	All respondents (n = 26)	Students with moderate or extensive shadowing experience (n = 17)	Students with no or some shadowing experience (n = 9)	p-value
Level of interest in medicine prior to shadowing (1–5)	4.72 ± 0.54	4.76 ± 0.44	4.63 ± 0.74	0.559
Level of interest in medicine after shadowing (1–5)	5.00 ± 0.0	5.00 ± 0.0	5.00 ± 0.0	NA ^a
Change in level of interest in medicine	0.28 ± 0.54	0.24 ± 0.44	0.38 ± 0.74	0.559
Level of interest in surgery prior to shadowing (1–5)	4.04 ± 0.89	3.94 ± 0.83	4.25 ± 1.04	0.429
Level of interest in surgery after shadowing (1–5)	4.72 ± 0.61	4.65 ± 0.70	4.88 ± 0.35	0.398
Change in level of interest in surgery	0.68 ± 0.75	0.71 ± 0.69	0.63 ± 0.92	0.807
Level of interest in CT prior to shadowing (1–5)	3.36 ± 0.86	3.29 ± 0.85	3.50 ± 0.93	0.588
Level of interest in CT after shadowing (1–5)	4.40 ± 0.65	4.41 ± 0.62	4.38 ± 0.74	0.898
Change in level of interest in CT	1.04 ± 0.89	1.12 ± 0.86	0.88 ± 0.99	0.536
Level of interest in associated medical school prior to shadowing (1–5)	3.68 ± 1.18	3.65 ± 1.22	3.75 ± 1.17	0.844
Level of interest in associated medical school after shadowing (1–5)	4.32 ± 0.99	4.12 ± 1.11	4.75 ± 0.46	0.139
Change in level of interest in associated medical school	0.64 ± 0.86	0.47 ± 0.72	1.00 ± 1.07	0.155

Values are mean ± SD unless otherwise indicated.

CT=cardiothoracic surgery.

^aCannot be computed because the standard deviations of both groups are zero.

programme with significantly higher levels of clinical exposure prior to shadowing ($p < 0.01$).

The question of whether or not shadowing physicians actually improves student interest in medicine directly correlates with the value of shadowing, both to the student shadower and the physician who embraces the role of a mentor. Previous studies have

attempted to answer this question with shadowing programmes of their own, and results suggest implementing shadowing programmes can have a positive impact on student interest.^{7,8} In our study, it was found that the shadowing programme significantly increased interest in cardiothoracic surgery, surgery, and medicine in general ($p < 0.01$). Importantly, our study found that

undergraduate students also indicated a high level of desire to perform well in classes after shadowing, with a Likert score of 4.76 out of 5.

These findings are especially relevant in the field of cardiothoracic surgery, because by the year 2030, a total workforce deficit of over 2000 cardiothoracic surgeons has been predicted in the United States of America alone.⁹ This projected deficit of cardiothoracic surgeons underscores a more generalised and larger projected deficit of 52,000 primary care physicians in the United States of America alone by 2025.¹⁰ Other issues exist that contribute to these projected shortages of physicians in general and cardiothoracic surgeons in particular, and many of these issues are beyond the scope of this article. Nevertheless, shadowing provides a unique opportunity to grow interest in medicine in young adults as they are making important and often permanent decisions about their future careers. Therefore, effective and impactful shadowing programmes should attempt to increase student interest in not only the specialty of the physician they shadow, but also in medicine in general, as was demonstrated in our study.

While shadowing can be a valuable and rewarding experience for both parties involved, it can be difficult for students without any connections to the medical field to find and participate in meaningful shadowing experiences and accumulate hours, as documented in our findings. While others have shown that having a physician relative may positively impact medical school admission, with some papers reporting that as many as 20% of medical students have a physician parent,^{11,12} the impact of having a physician as a relative on clinical exposure before medical school has not been shown.

Therefore, our study sought to quantitate the difference in clinical exposure between those with physician relatives or physician mentors and those without physician relatives or physician mentors. In comparing both students with ($n = 10$) and without ($n = 16$) a physician relative or mentor, our study found that students who reported having a physician relative or mentor also reported higher levels of clinical exposure prior to shadowing with the cardiothoracic surgeons in our Congenital Heart Center ($p < 0.01$). For some students without physician relatives or mentors, the shadowing programme with the cardiothoracic surgeons in the Congenital Heart Center represented their first clinical exposure of any kind.

This analysis lends itself to two deeply relevant conclusions. First, a significant divide exists in the opportunities available for students with physician relatives and mentors and students without physician relatives and mentors. Second, shadowing programmes, such as the one with the cardiothoracic surgeons in our Congenital Heart Center, encourage students to gain clinical exposure and help bridge the divide in opportunity between these two student groups.

This study highlights important differences between undergraduate students with and without physician relatives or mentors. Students without physician relatives and mentors often lack clinical exposure and confidence, along with critical opportunities for networking and relationship-building in medical and surgical settings; undoubtedly, such opportunities would better position these students for success. Shadowing is essential to provide students with real-life and interactive experiences, such as

- Networking and relationship-building, and
- Integrating across the medical environment.

Such opportunities provide the framework for future generations, because they provide the basis and learnings for what a career in medicine would look like.

The value of networking and relationship-building in the medical community cannot be underestimated among the most critical components of the academic and professional success of future physicians. Mentors and role models provide access, support, education, motivation, and knowledge for students, which all underscore the importance of shadowing opportunities. When evaluating the accessibility of shadowing opportunities, it is important to recognise the groups of students who would benefit most from an increase in the incidence of shadowing. Specifically, those without relatives or mentors in healthcare do not naturally gravitate towards the fields of health and medicine to the same extent as those with connections in the field. In order to achieve a more equitable future that includes a diversified demographic of medical professionals, more shadowing programmes with targeted outreach need to be available to support the academic and professional goals and aspirations of underrepresented populations. This analysis of the shadowing programme at University of Florida Congenital Heart Center demonstrates that by enabling early undergraduate shadowing for those within historically underrepresented socio-economic populations, unique opportunities for academic scholarship and professional success can be created with greater diversity, equity, and inclusion.

Limitations

As with any study that relies on self-reported survey data, it is possible that the results reported herein suffer from response bias. Students who had a strongly positive experience may have been more likely to respond to the survey than those who felt they gained little from the experience. Although the response rate in general was strong (70.2%), any non-participation leaves open the possibility of data that tell an incomplete picture. In addition, attempting to measure any subjective variable such as personal interest provides some level of uncertainty in the quantitative nature of the results. Likert scales represent a mechanism to quantify inherently qualitative data, but how individuals define their subjective interest on a 1–5 scale varies case-by-case.

Directions for future investigation

This study resulted in several important conclusions worthy of further analysis. The study revealed that this shadowing programme designed by the cardiothoracic surgeons in the University of Florida Congenital Heart Center increased student interest in cardiothoracic surgery, surgery of all kinds, and medicine in general. The study also revealed that students without physician relatives or mentors engage in significantly fewer hours of clinical exposure compared to their counterparts who have either a physician relative or mentor. Moving forward, better strategies may be developed to measure the impact of this shadowing programme using more objective metrics. Future follow-up with longitudinal studies that revisit these students should seek to determine whether the increase in interest in cardiothoracic surgery seen in this study was a transient effect due to recency bias or if these students continue to seek out opportunities in cardiothoracic surgery in rates higher than the average premedical or medical student without shadowing experiences. The divide in clinical

- Observing surgeons performing daily procedures,
- Engaging in interactions with patients, physicians, and the myriad of other members of the healthcare team,

exposure based on the presence of a physician relative or mentor is also a factor that should be examined further in future studies. The underlying reason for this divide has yet to be determined, and other variables should be considered as causative factors for this phenomenon.

Conclusion

A shadowing programme designed by the cardiothoracic surgeons in the University of Florida Congenital Heart Center increased student interest in cardiothoracic surgery, surgery of all kinds, and medicine in general. Students also indicated a high level of desire to perform well in classes after the experience, with a Likert score of 4.76 out of 5. Finally, prior to participating in this shadowing programme, students without physician relatives or mentors engaged in significantly fewer hours of clinical exposure compared to their counterparts who have either a physician relative or mentor. Such shadowing programmes can help bridge this gap of opportunity and potentially create a more diverse pool of students interested in and prepared for careers in cardiothoracic surgery, surgery of all kinds, and medicine in general.

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Conflicts of interest. None.

Ethical standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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