Health Career Academy: Addition of a Surgical Case-Based Learning Curriculum Captures the Interest of High School Students

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OBJECTIVE: The Health Career Academy (HCA) is a national program which provides a structure to introduce underserved high school students to healthcare careers. Utilizing the HCA framework, we adapted the curriculum to emphasize surgical cases and invited physicians to enrich the learning experience.

DESIGN, SETTING, AND PARTICIPANTS: Medical students adapted a surgical case-based learning (CBL) curriculum at a local high school serving students from a primarily ethnic minority and low-income community (61% Black, 20% Hispanic; 58% free or reduced lunch). Each grade level received a minimum of ten, 90-minute CBL sessions. Expert faculty lecturers supplemented lessons. Medical student volunteers and 10th and 11th grade students completed postsemester surveys.

RESULTS: Over four semesters, HCA held 44 sessions, with 81 students graduating from the program. A total of 66% of sessions featured at least one faculty volunteer. A total of 36 students in 10th and 11th grade and 15 medical student volunteers completed postparticipation surveys. A total of 46.2% of 11th grade students previously participated in the 10th grade curriculum. On a scale of 1 to 4, students rated HCA highly in its overview of career options (mean 3.61, [SD 0.5]) and instilling understanding of patient care (3.78 [0.42]). Students enjoyed learning about career paths (3.61 [0.50]) and health topics (3.83 [0.39]). Of 10th and 11th grade students, 100% considered a healthcare career, with 34.8% of 10th and 61.5% of 11th grade students expressing interest in pursuing a surgical specialty. After volunteering, medical students felt like better educators (4.47 [0.64]) and were more likely to pursue teaching roles (4.2 [0.86]).

CONCLUSIONS: The Duke HCA chapter implemented the HCA program featuring CBL sessions emphasizing surgical cases. This program engaged minority students and potentially contributed to student interest in surgical careers. It helped to prepare medical students for future teaching roles. An interactive, surgery-focused program may increase the number of minority youth interested in pursuing health careers. (J Surg Ed 76:401−407. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: case-based learning, surgical education, survey, high school, minority

COMPETENCIES: Practice-Based Learning and Improvement, Patient Care, Systems-Based Practice, Medical Knowledge, Interpersonal and Communication Skills, Professionalism

Racial and gender disparities among those pursuing health careers have improved over recent decades.[1-5] However, notable inequalities persist in the number of underrepresented minorities in general and subspecialty surgical fields.[6-9] Recent studies demonstrate that early exposure to mentorship and educational experiences in surgery may influence career choice.[10,11] Several after-school biomedical programs intended to garner student interest in health-related careers have shown positive impacts on rates of college and professional school matriculation, and proportions of science majors.[12-14]

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The Health Career Academy (HCA) is a national program, which provides health- and science-related education and mentorship to underserved 10th to 12th grade high school students in an effort to foster interest in healthcare careers.[15] The Duke Chapter of HCA has adapted the original HCA curriculum to deliver primarily surgery-focused, case-based learning (CBL) sessions. Over the course of a five-month semester, students learn the basic skills of presenting patient cases, interpreting laboratory values and disease complaints, formulating differential diagnoses, and creating management plans. We implemented an HCA framework supplemented with surgical education elements on a longitudinal basis to leverage the inherent engaging qualities of surgical intervention to capture student interest.

Our aim was to evaluate the impact of the Duke HCA program by administering postparticipation surveys to medical student instructors and high school student participants. We hypothesized that enrollment in HCA would foster student interest in surgical and related health careers, generate medical student interest in teaching, and serve as a rewarding and enjoyable experience to both groups.

MATERIALS AND METHODS

Program Overview and Enrolled Students

The Duke HCA chapter was established in 2016 with support from Duke University School of Medicine and Department of Surgery and the Health Career Academy national program. A minimum of ten, 90-minute sessions, including an introduction, end of semester small group presentation ("finale"), CBLs, and field trips were held with 20 to 30 students enrolled per semester. Sessions were designed and led by medical students and faculty from a variety of departments, with the Department of Surgery predominately involved. Positions in the program were open to all 10th and 11th grade high school students at a local high school. There was no student application process nor any attempt to include only high- or low-achieving students. Students elected to participate based on interest and availability. The program was free of charge to all students.

Case-Based Learning Curriculum

Two separate CBL curricula were designed for 10th and 11th grade students based on the HCA template curriculum. The 10th grade curriculum was held in the spring and the 11th grade curriculum in the fall. Specific surgical and medical pathologies were highlighted in each curriculum (Table 1). The 10th grade CBL sessions focus on instilling a systematic approach to patients requiring acute care or surgery. Sessions emphasized five key facets of care: (1) history taking, (2) physical exam maneuvers, (3) diagnostic tests, (4) assessment and differential diagnosis, and (5) treatment options and patient management. In line with the national HCA 11th grade framework,[16] the 11th grade CBL sessions emphasized public health components of surgical diseases. Sessions emphasized three key facets of care: (1) epidemiology, (2) screening and prevention, and (3) patient management.

TABLE 1. Case-Based Learning Lesson Topics by Grade Level, Health Career Academy, Duke School of Medicine and Department of Surgery, 2015 to 2017

10th Grade	11th Grade
Intro to Physical Exam Kickoff	Public Health Kickoff
Chest Pain	Epidemiology
Emergency Simulation	Infectious Disease
Acute Abdomen	Traumatic Brain Injury
Orthopedic Injury	Cardiovascular Disease
Infectious Disease	Cancer Screening
Radiology	Obesity and Nutrition
Surgical Oncology	Health Insurance
Transplant Surgery	Mental Health
Vascular Surgery	
Immunizations	

Case-Based Learning Session Format

Medical student or faculty leaders presented cases of real or simulated patients in PowerPoint format. Cases began with a one-line statement describing the clinical setting, patient demographics, and chief complaint. Students were first asked to collect a full medical history on the patient including: history of present illness, past medical and surgical history, family history, medications, allergies, vaccination status, and social history. A medical student or faculty instructor provided the history when asked based on either an entirely fictional or a de-identified patient. Students were then asked to describe the physical exam maneuvers that would be key in eliciting pertinent data from a patient. To highlight that providers must be mindful of cost, students were also asked to propose pertinent and cost-effective diagnostic labs and imaging techniques. Information on pertinent lab tests, imaging, physical exam components, and cost were built into each case and presented by the faculty and medical students. Finally, with the help of medical students, learners were encouraged to synthesize and interpret patient data to form a differential diagnosis and form management plans. Expert faculty provided current, evidence-based explanations throughout the session and

provided a direct link to the clinical experience of caring for patients such as those presented in the cases.

Hands-on workshops involving knot tying, suturing, intubation, and ventilation were also coupled with CBL sessions to sharpen basic technical skills. Physical exam skills (e.g. heart and lung auscultation, reflexes, blood pressure monitoring) were emphasized via practice sessions. Workshops were held at the local high school. Common medical instruments, such as stethoscopes and reflex hammers, were provided by medical student volunteers. Intubation supplies, manikins, and suturing kits were provided by the Duke Surgical Education and Activities Lab.

Field Trip Experience

To transform classroom learning into clinical experience, field trips to Duke Hospital were organized for both grade levels. These experiences involved a once-per-semester tour at an ACS Level 1 trauma bay and medevac facility, and incorporated lectures by trauma surgeons and nurses.

Final Project Experience

At the conclusion of each semester, HCA students demonstrated their cumulative knowledge by presenting a simulated patient case to a panel of medical students and faculty judges. Predesignated groups of 4 to 5 students created an original 10-minute CBL on a disease of their choice. The groups were given the opportunity to work with medical students in the weeks prior to their presentations to ask questions and get feedback on their rationale and understanding. These presentations emphasized key learning points accumulated throughout the semester. Judges evaluated each presentation and posed follow-up questions to each case in order to test deeper understanding of the diseases or correct any gaps in knowledge. Students received a certificate of completion following presentation of their final project at the end of each semester.

Postprogram Survey

Institutional Review Board exemption from Duke University was obtained (IRB #00092419), and anonymous hard-copy surveys were administered to the high school students and medical student volunteers at the end of each semester immediately following the final project experience. Students were instructed that all surveys were optional, anonymous, and would have no impact on completion or future participation in the program. The high school surveys gauged the program's impact on students' medical knowledge and desire to pursue a career in healthcare, especially surgery. For student career interest, surgical subspecialties were defined using guidelines from the American College of Surgeons.[17] The medical student survey gauged the efficacy of the program in conveying medical knowledge, and in fostering medical student interest in teaching. Surveys for 10th and 11th grade students were previously described.[15]

Data Analysis

Students who completed postparticipation surveys were included in the analysis. Likert-style questions were coded and stratified by grade level. Percentages, means, and standard deviations (SD) were calculated from survey data. All statistical analyses were performed using R statistical programming software version 3.3.0 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Participant Demographics

Over four semesters, 81 unique high school students graduated from HCA. To qualify as a graduate, a student must have a $\geq$50% attendance rate and participate in the finale. A total of 44 sessions were held with 66% of sessions attended by at least one faculty volunteer. Post-semester surveys were completed and returned by twenty-three 10th grade and thirteen 11th grade students. Overall, the population of the partner high school is 61% Black and 20% Hispanic; median household income is $41,694; and 58% of students receive free or reduced lunch.

10th Grade Survey

The 10th grade students from two semesters, Spring 2016 and Fall 2016, were surveyed. On a Likert scale of 1 to 4 (1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree), students rated HCA with mean [SD] scores of: 3.61 [0.5] for its overview of career options, 3.39 [0.58] for help in planning career goals, 3.43 [0.51] in fostering interest in healthcare careers, and

TABLE 2. 10th Grade Survey Aggregate Response from Fall 2015 and Fall 2016 (n=23)

Survey question	Score
HCA explored career options	3.61 (0.50)
HCA helped plan for career goals	3.39 (0.58)
HCA fostered interest in healthcare career	3.43 (0.51)
HCA helped understand patient care	3.78 (0.42)
Enjoyed interacting with medical students	3.78 (0.42)
Enjoyed learning about different careers	3.61 (0.50)
Enjoyed learning about various health topics	3.83 (0.39)

All data is presented as mean (SD) unless otherwise stated. Scores were averaged from a 1 to 4 Likert-style scale.[15]

3.78 [0.42] in helping to understand patients and pathology. Students also felt they benefited from interacting with medical students (3.78 [0.42]), enjoyed learning about various career paths (3.61 [0.50]), and about various health topics (3.83 [0.39]) (Table 2). 100% reported they considered a career in healthcare after the program, found the final project helpful, and would like to participate in the 11th grade curriculum. 21.7% expressed interest in a medicine subspecialty, and 34.8% expressed a desire to pursue a surgical subspecialty (Fig. 1a).

11th Grade Survey

The 11th grade students from the Fall 2017 semester were surveyed. A toal of 46.2% of the 81 unique graduates of the program had participated in the 10th grade HCA program. 92.3% of students felt the final project to be helpful in consolidating their learning. After completion of the curriculum, 84.6% of students expressed an interest in partaking in a 12th grade program and 100% of students intended to pursue a career in healthcare; 61.5% were interested in a surgical field, 30.8% in a medicine subspecialty, and 7.7% in nursing (Fig. 1b).

Medical Student Survey

A total of 15 medical students who volunteered between 2016 and 2017 were surveyed. A total of 66.7% volunteered five or more times for HCA, 66.7% led a lesson, and 60% created content for CBL sessions. On a scale of 1 to 5 (1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree), medical students rated the program: 4.67 [0.49] (mean [SD]) in helping high school students learn about career pathways, 4.07 [0.7] in helping students plan career goals, 4.67 [0.49] in fostering student interest in healthcare careers, and 4 [0.93] in teaching care for patients. Overall, medical students greatly enjoyed interacting with high school students (4.8 [0.41]) and felt that participating in the program made them more likely to pursue teaching roles (4.2 [0.86]) and made them better educators (4.47 [0.64]) (Table 3).

DISCUSSION

Using the inherent strength and flexibility of the HCA national framework, we created an interactive curriculum of surgical cases in order to capture student interest

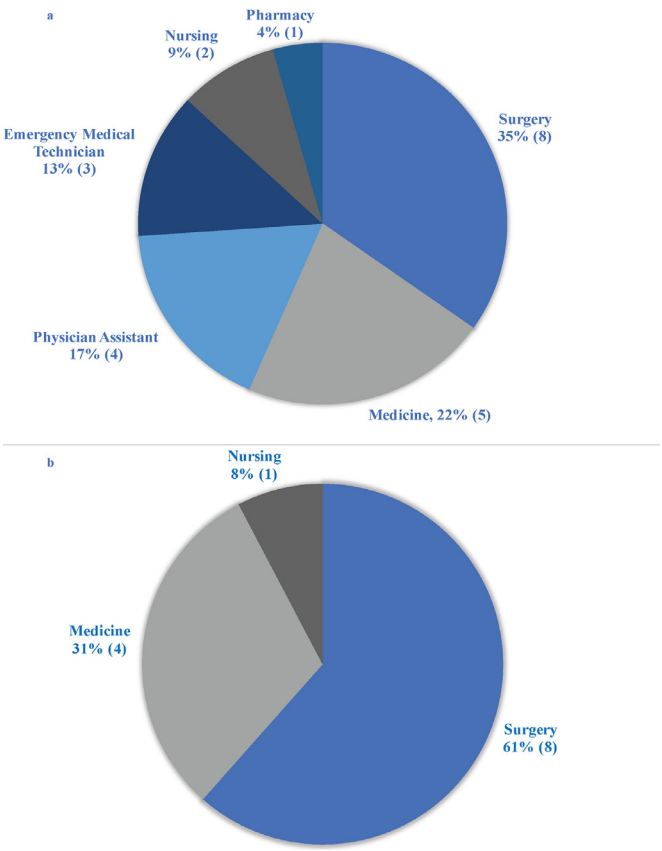

FIGURE 1. a. Pie Chart of 10th Grade Career Goals after a Semester with HCA (n=23) b. Pie Chart of 11th Grade Career Goals after a Semester with HCA (n=13).

TABLE 3. Medical student perception of HCA, Duke School of Medicine, 2016 to 2017 (n=15)

Survey Question	Score
HCA helped with learning about career pathways	4.67 (0.49)
HCA helped with planning career goals	4.07 (0.70)
HCA helped raise interest in healthcare careers	4.67 (0.49)
HCA modeled a diverse array of healthcare careers	3.80 (1.01)
HCA helped students understand patient care	4.00 (0.93)
HCA encouraged students to graduate from high school	4.53 (0.64)
HCA engaged students in community-based health promotion activities	3.33 (1.23)
I enjoyed time working with high school students	4.80 (0.41)
I feel like a better educator after participating in HCA	4.47 (0.64)
I am more likely to pursue an academic career after HCA	3.87 (0.92)
I am more interested in surgery after HCA	4.00 (0.85)
I am more likely to volunteer in an educational setting after HCA	3.66 (0.82)
I am more likely to pursue teaching roles in my career after HCA	4.20 (0.86)

All data is presented as mean (SD) unless otherwise stated.
Scores were averaged from a Likert scale: 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree.

in surgery. By focusing on the inspirational and interventional thinking of primarily surgical pathologies and therapies, we were able to create a high school program that was innovative in lesson style, access to faculty members, and provided a longitudinal experience for students. Our data demonstrate Duke HCA's potential to attract minority and low-income students to healthcare fields via a surgical lens. Data also show a growth in medical student desire to teach. Given that our medical student mentors are primarily pursuing surgical careers, this may also serve to benefit the future culture of surgical education as a whole.

There are many pipeline programs that aim to encourage underrepresented youth to choose a career in healthcare.[15,18] However, little has been published on performance and efficacy metrics, especially for high school programs with a specifically surgical theme. The University of California Irvine Summer Surgery Program is a two-week surgery-focused experience for *select* high school students. Similar to our program, UC Irvine's program has shown the potential for early educational intervention to motivate underrepresented high school students to purse health careers and better understand their individual career goals.[19] Additionally, the Stanford Cardiothoracic Surgical Skills Summer Program has introduced surgical topics to high school students through knot tying, dissection, and suturing workshops.[20] We have leveraged a similar set of hands-on skills, with additional experiences in our Surgical Education and Activities Lab and in tours of our trauma bay and Life Flight medevac helicopters.[21] Compared to existing programs, our surgery-oriented curriculum is unique in its five-month duration and encourages students to return a year later to allow them to build upon previous knowledge. To our understanding, the Duke HCA program is the only multi-year, semester-long, surgery-focused program for high school students.

Our adaptation of the HCA curriculum demonstrated a focus on surgical topics and addition of more standardized CBL methodological approach.[15] The CBL is a pioneering lesson structure, utilized in many medical school curricula to simulate real-world scenarios in order to more effectively engender skills in clinical management. Our collaborative CBL approach indeed encourages the HCA principles of collaboration, critical thinking, and communication, and emphasizes application of knowledge.[22,23] Incorporating expert faculty to provide direct windows into patient care as it relates to the case enhances the experience of the high school students and allows medical students to focus more on leadership roles involving group management and facilitation within the classroom. Our success using CBL sessions demonstrates the robustness and plasticity of the foundational framework presented by the national HCA curriculum.

Similar to the national HCA program, our program was able to help students plan their career goals, explore various career options, become interested in healthcare, and learn to care for patients. Notably, our program reported a higher percentage of students considering a career in healthcare than the national average for the HCA program; this rate further increased in successive semesters.[15] A total of 57% of our 10th grade students aimed to become physicians compared to the national rate of 40%, with 35% of those intending to become a surgeon.

After our 11th grade curriculum, 62% of our students intended to pursue a surgical career.

As the first HCA chapter started by a surgical interest group and with a significant focus on surgical disease, these results are not surprising. Whereas our program is based firmly on the national Health Career Academy curriculum,

the unique nature of Duke HCA chapter demonstrates that medical student mentors can leverage and imbed site-specific interests and resources (e.g. surgery interest groups) within the broader HCA framework to successfully stimulate interest in health careers. Additionally, our data demonstrate that an early, positive introduction to surgery through our curriculum and faculty volunteers may increase the number of minority youth interested in pursuing health care careers related to surgical specialties.

Our program has the additional benefit of preparing medical students for teaching roles as residents and for their future careers as educators in academic medical centers. Often, residents at academic medical centers are responsible for the education of medical students. However, few residency programs are able to confer opportunities for residents to become proficient in teaching.[24] Medical student volunteers overall enjoyed the teaching experience and felt that involvement in the program improved their skills as educators. Furthermore, these students expressed that the program had increased their motivation to pursue future teaching roles. Indeed, the effective teaching skills developed in our program provide students with the skills necessary to achieve success as educators in their roles as residents and faculty members in the future.

The national program reports that the primary challenge in HCA's sustainability is logistical, largely due to inconsistent student attendance because of evolving extracurricular schedules and difficulty ensuring reliable transportation.[15] Recognizing these obstacles, we coordinated with high school administration well in advance of each HCA semester to overlay high school and medical school academic calendars. We set the sessions to occur on the same day each week to promote a sense of regularity for student and volunteer schedules and to encourage maximum attendance. Furthermore, we utilized private bus companies to ensure reliable transportation for field trips, which is one of the program's largest expenses. The Duke HCA chapter's long-term sustainability has been secured through partnership and funding with the national HCA program and the Duke Department of Surgery, specifically the Duke Surgery Education Research Group.

There are several limitations to our study. First, some students may not have been present to complete post-participation surveys, which could have selected for those committed to attending all sessions or had a more favorable perception of HCA. Additionally, we did not survey those students who did not choose to continue on from the 10th grade program to the 11th grade program. This information could be valuable in increasing attendance and excitement for the program in future years. Further, the program itself could have selected for students who were inherently interested in healthcare careers. This selection bias could be assessed through presemester surveys, which have been implemented for future semesters. Moreover, we were unable to assess the extent of the program's impact on students' intentions to attend college.

Future Directions

Long-term follow-up is warranted to compare college and professional school matriculation rates in graduates of our program compared with peers at their high school.

We will longitudinally follow program alumni with post-graduation surveys. Additionally, surveying a control group of non-participants would allow for a quantitative comparison analysis. It is also our goal to expand the program to include the 12th grade HCA curricula which would ensure support to high school students through graduation. Lastly, the HCA national program has invited us to share our unique curricular elements with medical schools across the country who are implementing the program. By publishing our curricula on the national website or as Free Open Access Medical Education, medical students and faculty will be able to provide this opportunity to underrepresented minority and low-income high school students on a larger scale.[16,25]

CONCLUSIONS

Encouraging minority and low-income students to become medical practitioners, especially in surgery, is an essential part of addressing health disparities. Using the HCA national framework, we created a unique curriculum consisting of surgical CBL sessions. We were able to provide longitudinal experiences and early, positive interaction with surgeons, which may encourage high school students to consider surgical careers. Our program reported a high proportion of students considering careers in surgical specialties. Additionally, our program helped medical students garner valuable teaching experience and confidence in their skills as educators. Overall, these results show that our unique surgery-focused program was very positively perceived by both student participants and facilitators. Student experiences in this program have the potential to increase the number of minority youth considering surgery.

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