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Democratizing Access to Neurosurgical Medical Education: National Efforts in a Medical Student Training Camp During Coronavirus Disease 2019

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■ **BACKGROUND:** National medical student surveys amidst the coronavirus disease 2019 (COVID-19)–driven subinternship cancellations have demonstrated the need for supplemental, standardized subspecialty medical education, mentorship, and career planning nationally. We have presented the first live, cross-institutional virtual medical student subspecialty training camp to deliver standardized neurosurgical educational content to medical students during the COVID-19 pandemic, and its results on medical student anxiety and perceptions of neurosurgery.

■ **METHODS:** The online training camp used a video conferencing platform that was open to all medical students. A post-training camp survey was administered.

■ **RESULTS:** A total of 305 medical students registered for the event from 107 unique U.S. medical schools. Of the 305 medical students, 108 reported intending to apply to neurosurgery residency in 2021. The top medical student objectives for the training camp were program networking and mentorship. Of the 305 participants, 121 (39.7%) completed the post-training survey. Of the respondents, 65.0% reported improved neurosurgical knowledge, 79.8% reported decreased anxiety about subinternships and interviews, 82.5% reported increased enthusiasm about neurosurgery, and 100% desired a future annual virtual training camp because of the increased accessibility and decreased cost. This was especially important for students at institutions without home subspecialty programs and those with financial burdens.

■ **CONCLUSIONS:** COVID-19–driven innovations in medical education have accelerated changes that may have long been necessary. This virtual structure improved resource usage and scalability compared with in-person training, maintained social distancing, and democratized access to standardized, specialized content not often available through traditional medical curricula. Even as a supplement to in-person events, the virtual training camp model could be implemented by national medical societies, which might significantly increase medical students' preparedness for, and education in, neurosurgery and other subspecialties.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has brought significant fundamental changes to medical care, resources, training, and education. Early attention was appropriately placed on clinical adaptations to ensure that patients and providers had all the safeguards possible in place during COVID-19 to preserve life and “flatten the curve.” Similarly, many changes have been made to clinical neurosurgery practice and resident research and training.¹⁻³ However, efforts to minimize the significant effects on subspecialty medical student (MS) education (MSE) have received less attention but could, arguably, have longer term effects, especially on subspecialty fields.^{4,5}

On March 17, 2020, the Association of American Medical Colleges recommended a suspension of MS clinical rotations.⁶ Also, on April

Key words

- COVID-19 pandemic
- Medical student education
- Neurosurgery training camp
- Virtual education

Abbreviations and Acronyms

COVID-19: Coronavirus disease 2019

MS3: Third-year medical student

MS4: Fourth-year medical student

MS: Medical student

MSE: Medical student education

NRMP: National Resident Matching Program

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28, 2020, The Society for Neurologic Surgeons recommended that all external neurosurgery rotations (externships) for MSs be deferred for 2020.⁷ Meaningful subspecialty experiences will, therefore, for the first time in decades, be absent from many fourth-year MSs (MS4s) training and, potentially, will be abbreviated for many third-year MSs (MS3s) because of delays in medical school core rotations. Owing to the increasingly limited exposure to subspecialty training during medical school, especially in neurosurgery,⁸ clerkship and subspecialty clinical experiences have become necessary for accruing both skill acquisition⁹ and clinical experience and testing interests in various clinical subspecialties.^{10,11}

Even before the pandemic, there was a perceived need to supplement MSE in neurosurgery before matriculation into neurosurgical residency. A neurosurgery intern boot camp was established in 2009 to improve residency preparedness,^{12,13} followed by an in-person neurosurgery MS training camp in 2018.^{14,15} The latter demonstrated a measured improvement in clinical skills and neurosurgical knowledge but had had much greater interest expressed than available capacity.

The need for greater subspecialty exposure reported by MSs interested in neurosurgery has been further amplified by the pandemic. Of MS3s surveyed, 76% reported ≥ 1 cancelled or postponed neurosurgery rotation in 2020, and many MSs have reported a lack of readiness for neurosurgery residency applications.¹⁶ In national surveys, MSs reported they were more likely to take 1 year off from medical school after the start of the pandemic,¹⁶ 1 in 3 first-year MSs were dissatisfied with the neurosurgical career planning offered by their home medical school during the pandemic, and almost 1 in 5 MSs reported they were less likely to pursue a career in neurosurgery.⁵

Overall, the highest rated educational interventions reported by MSs in surveys have been virtual mentorship pairings (suggested by first- and second-year MSs), virtual surgical skill workshops (suggested by MS3s and MS4s),¹⁶ and focused webinars and conferences (suggested by all aggregated MSs).⁵ The neurosurgical community has been summoned to help abate these shortcomings in MSE during COVID-19 by offering additional virtual MSE opportunities,¹⁷ virtual opportunities for mentorship, and providing MSs with training camp-style material to prepare for their internship year, even in the absence of in-person gatherings.^{5,17}

Responding to these pandemic-driven needs, we developed a cross-institutional virtually compatible 1-day training curriculum appropriate for all levels of MSs.

METHODS

Eight neurosurgery residency institutions (listed in the Acknowledgments) participated in a 1-day virtual neurosurgery West Coast MS training camp from 8 AM to 2:30 PM (Pacific time) on Saturday, June 13, 2020. Five institutions participated in the East Coast session, which had started 3 hours earlier than the West Coast session to account for the time zone difference and allow for greater national involvement. The West Coast program ended the day with a small-group virtual mentoring session between the MSs and attending neurosurgeons. A virtual communication platform (Zoom Video Communications, Inc., San Jose, California, USA) was used to create virtual “rooms” for overlapping course

offerings. The “breakout room” function was used at the end of the day for the largescale mentoring sessions.

The course content ranged from the professional and academic aspects of neurosurgery to technical didactic lectures (Table 1; West Coast). The 305 MS participants who had participated in the West Coast session were sent a survey via e-mail and via the video platform chat function at the end of the training camp to assess the course effectiveness using a virtual format and its effects on the attitudes of the MSs toward neurosurgery. The responses were voluntary and anonymous, and the respondents were not required to answer all questions for survey submission. Aside from the demographic and contact information questions, 9 multiple choice questions were included to provide quantitative metrics about the course content, and 4 free-response questions were included to provide qualitative responses about the event. The MSs were invited to provide details about the course content or structure to repeat during future events and recommendations for improvement. The respondents were given 2 weeks to complete the survey after the event, with a reminder e-mail sent at the 1-week mark. The following results are specific to the West Coast session.

RESULTS

A total of 305 participants had registered for the West Coast session. The distribution of MSs by academic year is shown in Table 2. Of the 305 participants, 108 (35.4%) reported they intended to apply for neurosurgery residency in the 2020–2021 National Resident Matching Program (NRMP) cycle (Table 2). Using the NRMP data from 2020, of 273 U.S. applicants to neurosurgery who will be applying in the upcoming NRMP cycle, 100 (~36.7%) had registered for the West Coast session.¹⁸

Throughout the course, a minimum of 203 participants were present on the virtual platform. Applicants for the upcoming 2020–2021 NRMP cycle were offered participation in a small-group mentoring session composed of 3–5 other MS applicants for the same cycle and 1 attending neurosurgeon. Of the registered MSs applying in this NRMP cycle, 102 (94.4%) had attended the small-group mentoring session. In addition, 95 participants (31.1%) had attended the breakout panel on “Women in Neurosurgery.”

The 305 MS participants represented 165 unique institutions: 107 U.S. medical schools (64.8%), 9 U.S. osteopathic schools (5.5%), and 49 international medical institutions (29.7%). Twelve participants (3.9%) did not list a medical school affiliation.

There were 26 attending neurosurgery physicians, 2 program coordinators, and 15 neurosurgical resident panelists and lecturers. Of the 26 attending neurosurgeons, 5 (19.2%) were chairpersons and 7 (26.9%) were program directors or assistant program directors. The residents ranged from incoming residents to graduating seventh-year residents.

The post-event survey was completed by 121 MS participants (39.7% response rate). The respondents were not required to answer all questions. All respondents (100%) indicated that a future annual virtual neurosurgery training camp should be held irrespective of COVID-19 limitations or a concurrent in-person event. The reason selected most often for continuing a virtual format in the future was to increase participant access to the content ($n = 82$; 68.3%), followed by increasing the number of

Table 1. Summary of West Coast Curriculum

Session Structure	Session Title
Lecture	Overview of neurosurgery subspecialty and match/job process
Panel	What programs look for in an applicant
Lecture	General advice for medical students considering neurosurgery
Lecture	How to ace your subinternship, even during COVID-19
Panel	What to look for in selecting a residency training program
Panel plus presentation	Research in neuroscience and neurosurgery
Panel plus presentation	Advice and resources from residency program administrators
Panel	“Why neurosurgery?” (with recently matched medical students and interns)
Panel	Being a woman in neurosurgery
Panel	A day in the life of a neurosurgery resident
Lecture	Avoiding burnout in neurosurgery residency (and beyond)
Laboratory presentation	Simple cranial dissection
Small group presentation	Intracranial pressure management and cranial trauma
Small group presentation	Basic neuronavigation set up, common instrument names and how to use them, what to do in the OR
Small group presentation	Reading neuroradiology
Small group presentation	Spine trauma: evaluation and management of C1 and C2 fractures
Small group presentation	Tumor case presentation
Small group breakouts	Attending physician mentoring sessions

COVID-19, coronavirus disease 2019; OR, operating room.

participating programs ($n = 80$; 66.7%) and decreased cost ($n = 75$; 62.5%; **Figure 1**). Unsolicited comments included that the virtual platform and flexible registration allowed for the inclusion of international medical graduates, recent U.S. medical graduates, preliminary year residents interested in switching to neurosurgery, underrepresented minorities, and students with significant financial burdens or without a home neurosurgery program.

The MS objectives for the training camp were networking ($n = 72$; 60.0%), mentorship ($n = 60$; 50%), interview preparation ($n = 57$; 47.5%), and subinternship selection ($n = 51$; 42.5%). The least important objective was resume review ($n = 11$; 9.2%), followed by help in gauging interest in neurosurgery ($n = 27$; 22.5%) and tactile skill development ($n = 29$; 24.2%; **Figure 2**).

Regarding the respondents' change in their attitude toward neurosurgery after the event, on a scale of 1 (less enthusiastic) to 5 (more enthusiastic), 82.5% reported a score of 4–5 (more

Table 2. West Coast Registrant Academic Demographics

Variable	n (%)
Total West Coast registrants	305 (100)
MS1	63 (20.7)
MS2	32 (10.5)
MS3	52 (17.0)
MS4	86 (28.2)
MD/PhD candidate in PhD years	37 (12.1)
Other*	35 (11.5)
Intending to apply for neurosurgery in 2020–2021 NRMP cycle	108 (35.4)
Intending to apply for 2021–2022 NRMP cycle	59 (19.3)
Intending to apply for neurosurgery (nonidentified NRMP cycle)	123 (49.3)
No intentions of applying for neurosurgery residency	15 (4.9)

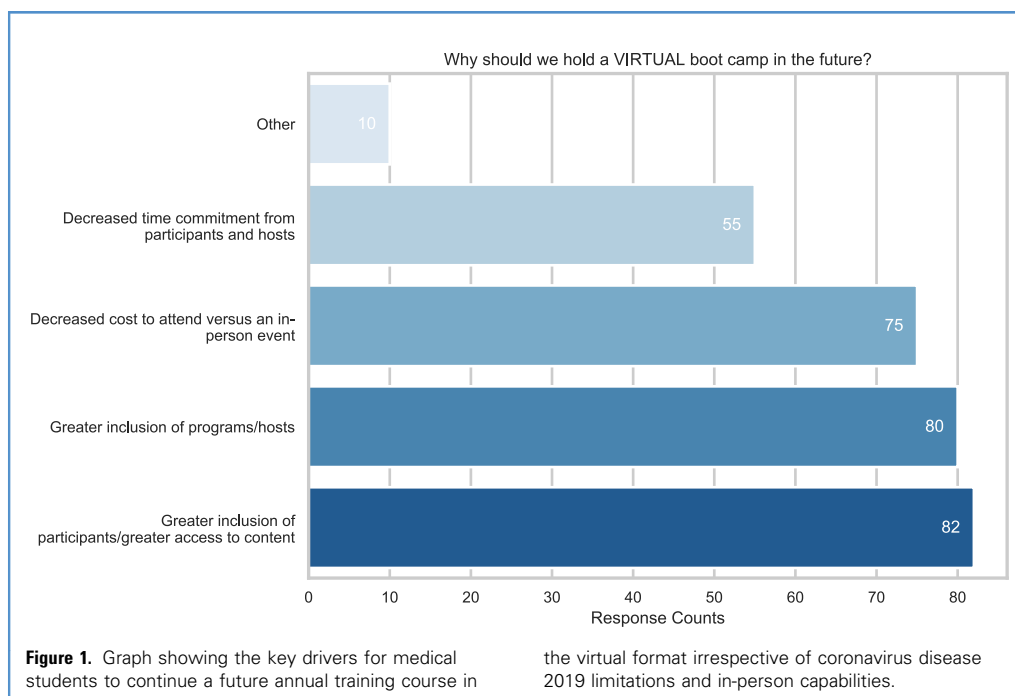
MS, medical student; NRMP, National Residency Match Program.
*International medical graduate, non-PhD research year, other degrees, recent graduate.

enthusiastic; **Figure 3A**). The free-text comments from 2 second-year MSs indicated that they had initially been interested in pursuing other specialties but that after the event were more interested in neurosurgery than in their previously intended subspecialty.

After the event, 79.8% of the respondents' anxiety levels about the neurosurgery application and/or subinternship process for the upcoming academic year had decreased or greatly decreased (**Figure 3B**). The participants were also asked to rate the change in their knowledge of neurosurgery after the event compared with before the event using a 5-point scale (1, no change to 5, greatly improved). Of the respondents, 65.0% had selected a score of 4–5, 34.2% a score of 2–3, and 0.8% a score of 1 (**Figure 3C**).

The highest rated sessions (not including the mentoring session for MS4s) were “What programs look for in an applicant” (panel of neurosurgery chair persons), “How to ace your sub-internship even during COVID-19,” and “What to look for in selecting a residency program” (panel of neurosurgery program directors). The free-text comments indicated that the mentoring session attended by MS4s, the Women in Neurosurgery Panel, and the unstructured virtual meet-and-greet at the end of the event were widely considered to be some of the most novel and helpful sessions of the event. The virtual meet-and-greet was an open, unstructured virtual “room” that any MS or attending or resident neurosurgeon could join at the end of the day to address any final questions. The session was scheduled for 15 minutes but organically had lasted for 2 hours with >70 participants at all times until it was closed by the host.

Recurrent themes for event strengths included the variety of speakers, the ability to casually interact with attendings and residents from numerous programs, the efficiency of the event to deliver a large and varied amount of content, and the ease of transition between sessions. Recurrent themes for methods to improve the event in the future included lengthening the



event, having more directed didactic sessions, and providing more advice on how to be an outstanding subintern or interviewee.

DISCUSSION

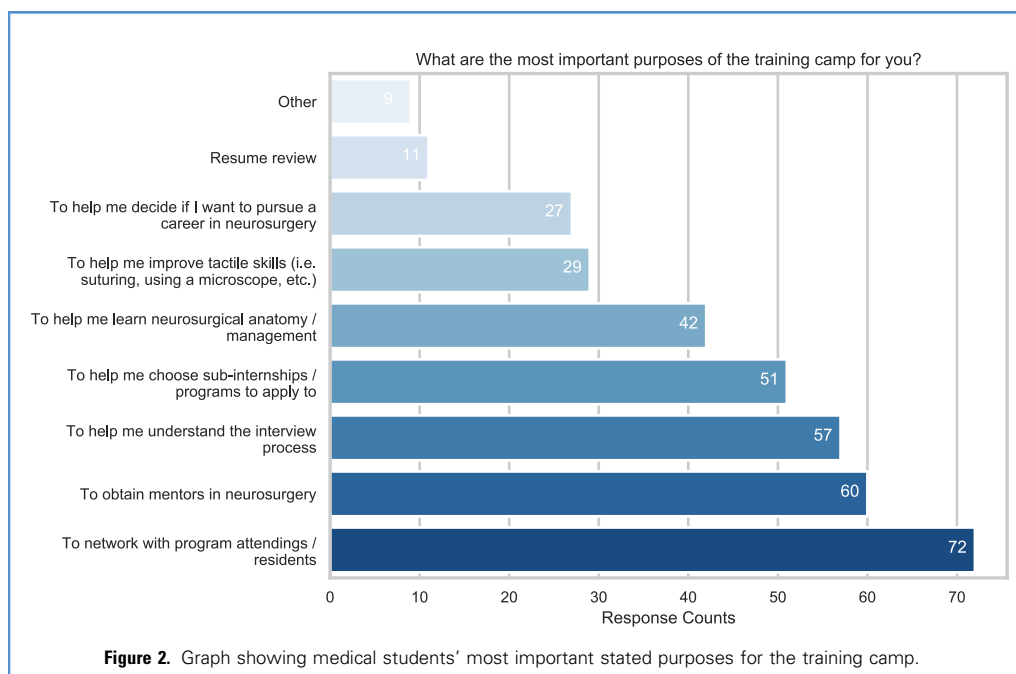
The COVID-19 pandemic has turned much of academic medicine's educational focus to virtual platforms out of necessity. Although the shutdown of in-person medical education¹⁹ and the need to transition to virtual platforms²⁰ was tested in 2003 during the severe acute respiratory syndrome pandemic, great advancements have occurred in virtual education capabilities and greater public access to technology since then. Neurosurgical societies have developed infrastructure to deliver high-quality interactive²¹ and live single-lecture educational content^{22,23} to resident and career neurosurgeons during COVID-19, in addition to various local efforts to share institutional content through virtual lectures.²⁴⁻²⁸ However, a paucity of instructional content pertaining to MS neurosurgical education has remained, especially given MSs' inability to participate in away subinternships amidst COVID-19 in the United States.²³

In response to a demonstrated desire from MSs interested in neurosurgery for increased subspecialty contact, MS-specific neurosurgical didactic content, guidance on preparing for neurosurgery applications and subinternships, and opportunities for mentorship and career planning, we developed and implemented an internationally accessible virtual cross-institutional training camp to bolster standardized MS neurosurgery education in these areas. To the best of our knowledge, we have presented the first nationally organized virtual conference subspecialty training camp for MSE.

Despite previous live in-person neurosurgery training events, the transition to a virtual platform was widely accepted by all the MS and content provider participants. All respondents reported that the training camp should be offered virtually in the future, regardless of concurrent in-person events, citing accessibility and cost-effectiveness as unique virtual utilities that in-person events did not have.

The scalability and accessibility of a virtual event were also demonstrated by the sheer number of participants. The first live neurosurgery training camp in 2018 reported 83 MSs from 32 medical schools representing the eastern and central United States, 5 international MSs, and 5 resident and 12 faculty member lecturers and/or panelists. In 2019, the in-person events of 2 institutions had had 191 MS participants and 65 medical schools represented. Our single virtual session (West Coast only) included 305 MS registrants and 43 neurosurgery program representatives; larger than the 2 previous in-person events combined.

One of the stated limitations of previous in-person training courses was the overwhelming demand.^{14,15} Although technical challenges associated with increasing participant numbers even for virtual event platforms remain, the content delivered directly to the participant's personal screen is easily visible, and a person's location is no longer a limitation as long as internet access is available. Several panelists were able to dial in while at work or during vacation. Although considerations of time zones for the live events were factored in (hence, the staggered session time offerings), both sessions were recorded to allow for delayed playback at the participant's convenience. Given the feedback for more content and for a longer event, the relative ease of scalability on a virtual platform versus an in-person



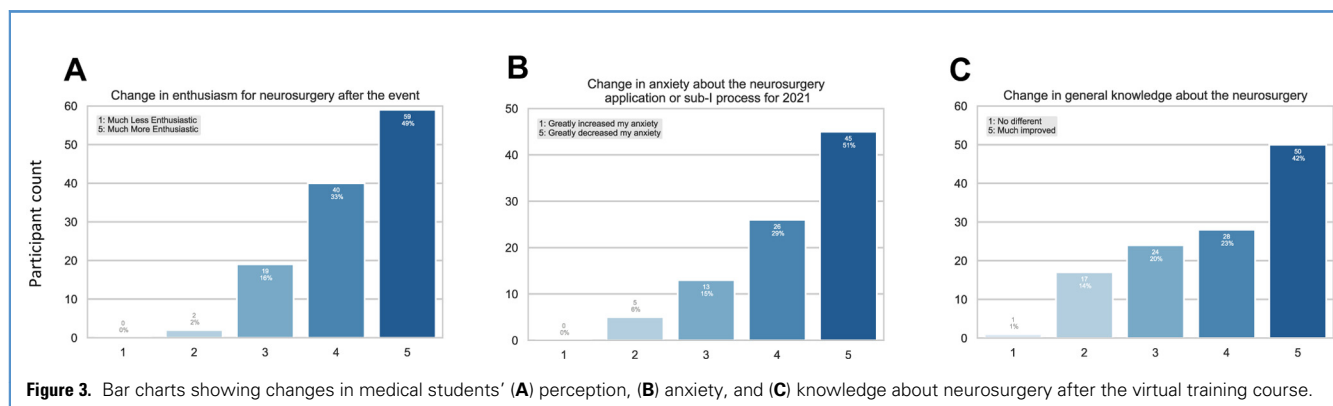
event could allow for a future multiday event with greater participation from neurosurgery physician educators.

Increased participant accessibility also allowed for significant involvement of international MSs and could allow for expansion of this event to students even earlier in their training, namely undergraduate students interested in medicine. This could be especially valuable because evidence supports the benefits of early exposure to neurosurgery to help MSs determine their interest and skill within the specialty^{10,11} and could also help undergraduates interested in medicine.²⁹ The virtual platform would also make it easier to organize various level-appropriate programming and breakout sessions within the same conference setting in the future, given greater educator participation.

Although the survey responses could have been limited by a response bias (the respondents knew that the results could inform future neurosurgical education programming) and a selection bias

(the participants had a self-selected interest in attending a full-day event about neurosurgery MS education), we had an overwhelming positive response rate (100%) to repeat this event in virtual format in the future.

On devising this course, one of the main limitations faced with the virtual platform compared with an in-person training camp was the inability to give direct feedback on manual technical skills. This had resulted from the overwhelming participant/instructor ratio and an inability to virtually share access to the necessary supplies or equipment in their personal environment. However, one of the least common drivers for MS participation in these training camps was to increase their technical skills. The primary stated impetus from the MSs to participate in the event was "access to the field" through interactions with various programs and to learn neurosurgical content and appropriate professional behavior that would help them succeed when interacting with



programs (e.g., subinternships, research opportunities, interviews).

Given the success of this event, the desire for a future virtual offering, and the overwhelming desire for more, nationally organized, high-volume, high-yield, efficiently delivered neurosurgical content expressed by the MSs, we envision future offerings as a combination of virtual and in-person events. Such events would use the strengths of each platform, maximizing access via a virtual environment and providing longer, more focused hands-on learning and laboratory sessions during in-person training.

With advancements in virtual platform communication, including expanded participant capacity, more seamless transitions between breakout rooms, and new developments that remove virtual barriers with integrated technologies (e.g., real time polling, “live operating rooms”), virtual platforms could serve as the primary mode of desired content delivery for such future events. It would also democratize access to content for MSs without a home neurosurgery program by providing a standardized, national neurosurgery subinternship preparatory course.

Given the likely importance of subspecialty exposure to promote matriculation into other niche medical fields outside of neurosurgery, we have offered this event structure as guidance to other national medical societies seeking to promote MSE within their field.

CONCLUSIONS

The overwhelming positive response from MSs to our virtual, standardized, national subspecialty training camp suggests that the necessary COVID-19–driven innovations in MSE might have long been needed. The nationwide impetus for familiarity with virtual platforms during COVID-19 has made these training camps accessible on a larger scale within medicine. It has also made MS access to attending and resident neurosurgeon educators in some ways more available than ever before.

During the pandemic, this event for MSs increased positive awareness of neurosurgery, increasing perceived neurosurgical knowledge, and decreased anxiety about the neurosurgery application and subinternship process. The virtual training camp improved disease prevention, cost and resource conservation, and scalability compared with in-person training. This national virtual subspecialty training course could serve as a model for national

medical societies in other disciplines to promote enhanced learning, professionalism, visibility, and interactions between MSs and those society’s providers. It could also help deliver standardized subspecialized content not often available through traditional medical curricula, especially to students in more resource-limited settings.

CRedit AUTHORSHIP CONTRIBUTION STATEMENT

Jasmine A. Thum DiCesare: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. **David J. Segar:** Conceptualization, Data curation, Formal analysis, Software, Validation, Visualization, Writing - original draft, Writing - review & editing. **Daniel Donoho:** Conceptualization, Methodology, Project administration, Resources, Writing - review & editing. **Ryan Radwanski:** Project administration, Resources, Software, Supervision, Writing - review & editing. **Gabriel Zada:** Conceptualization, Resources, Supervision, Writing - review & editing. **Isaac Yang:** Conceptualization, Resources, Supervision, Writing - review & editing.

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