Title

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

Authors

Thum DiCesare, Jasmine A
Segar, David J
Donoho, Daniel
et al.

Publication Date

2020-12-01

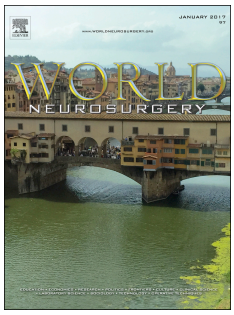
DOI

10.1016/j.wneu.2020.08.100

Peer reviewed

Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal Pre-proof



Democratizing Access to Neurosurgical Medical Education: National Efforts in a Medical Student Training Camp During COVID-19

Jasmine A. Thum DiCesare, M.S.E, M.D., David J. Segar, M.D., Daniel Donoho, M.D., Ryan Radwanski, M.D., Gabriel Zada, M.D., Isaac Yang, M.D.

PII: S1878-8750(20)31867-2

DOI: https://doi.org/10.1016/j.wneu.2020.08.100

Reference: WNEU 15796

To appear in: *World Neurosurgery*

Received Date: 28 July 2020

Revised Date: 12 August 2020

Accepted Date: 13 August 2020

Please cite this article as: Thum DiCesare JA, Segar DJ, Donoho D, Radwanski R, Zada G, Yang I, Democratizing Access to Neurosurgical Medical Education: National Efforts in a Medical Student Training Camp During COVID-19, *World Neurosurgery* (2020), doi: https://doi.org/10.1016/j.wneu.2020.08.100.

Democratizing Access to Neurosurgical Medical Education: National Efforts in a Medical Student Training Camp During COVID-19

Shortened Title: Democratizing Access to Neurosurgical Education

Jasmine A. Thum DiCesare, M.S.E, M.D.[1], David J. Segar, M.D.[2], Daniel Donoho, M.D.[3], Ryan Radwanski, M.D.[4], Gabriel Zada, M.D.[3], Isaac Yang, M.D.[1]

[1] Department of Neurosurgery, University of California Los Angeles, David Geffen School of Medicine, Los Angeles, CA, USA
[2] Department of Neurosurgery, Brigham and Women's Hospital, Harvard Medical School Boston, MA, USA
[3] Department of Neurosurgery, University of Southern California, Keck School of Medicine, Los Angeles, CA, USA
[4] Department of Neurosurgery, New York Presbyterian, Cornell, New York, NY, USA

Correspondence to:
Jasmine A. Thum DiCesare, M.D.
Department of Neurosurgery
300 Stein Plaza, Suite 420,
Los Angeles, California 90095
P: +1(310) 825-5111
F: +1(310) 825-7245
jthum@mednet.ucla.edu

Abstract word count: 249
Text word count: 2619
Number of references: 29
Number of tables / figures: 2/3

Key Words: Medical student education, neurosurgery training camp, virtual education, COVID-19 pandemic

This paper has not been presented or published previously in part or in full.

Disclosures: The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Funding: Funding sources had no active role in conducting research. Zoom hosting was enabled by the Brain and Spine Group, a non-profit organization.

Acknowledgments: All authors who contributed to this manuscript preparation met the criteria of authorship. The authors thank the support staff and from the Department of Neurological Surgery at the University of California, Los Angeles (Colleen Bruton) and the University of Southern California (Katherine Guzman), and the attendings and residents from these institutions that comprised the majority of the panelists. We would also like to thank the visiting professors from

the following participating Departments of Neurosurgery: Cedars-Sinai, Stanford, University of California Davis, University of California Irvine, University of California San Diego, and University of California San Francisco. The authors would also like to thank the Brain and Spine Group, Medical Student Neurosurgery Training Center for their technical assistance with the event (https://www.neurosurgerytraining.org/vtc.html) and for posting the recorded didactic sessions from this event online (https://www.neurosurgerytraining.org/video-library.html or https://www.youtube.com/playlist?list=PLv5QuGJwLeYHUXLeowEmL0PgSFBsjWEr8).

Abstract

Background: National medical student surveys amidst COVID-19-driven sub-internship cancellations demonstrate the need for supplemental, standardized subspecialty medical education, mentorship, and career planning nationally. We present the first live, cross-institutional virtual medical student subspecialty training camp to deliver standardized neurosurgical educational content to medical students during the pandemic, and its results on medical student anxiety and perceptions of neurosurgery.

Methods: The online training camp utilized a video conferencing platform, open to all medical students. A post-training camp survey was administered.

Results: 305 medical students registered for the event from 107 unique U.S. medical schools. 108 registrants intend to apply to neurosurgery residency in 2021. Top medical student objectives for the training camp were program networking and mentorship. 121 (39.7%) medical students completed the post-event survey; 65.0% reported improved neurosurgical knowledge, 79.8% had decreased anxiety about sub-internships and interviews, 82.5% reported increased enthusiasm about neurosurgery, and 100% desired a future annual virtual training camp due to increased accessibility and decreased cost. This was particularly important for students at institutions without home subspecialty programs, or with financial burdens.

Conclusions: COVID-19 driven innovations in medical education have accelerated changes that may have long-been necessary. This virtual structure improves resource utilization and scalability compared to in-person training, maintains social distancing, and democratizes 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 may be implemented by national medical societies, which may 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 has appropriately been placed on clinical adaptations to ensure that patients and providers undergo all safeguards possible during COVID-19 to preserve life and "flatten the curve". Similarly, many changes have been made to clinical neurosurgery practice,[1] and resident research[2] and training[3]. However, efforts to minimize the significant impacts on subspecialty medical student (MS) education (MSE)[4] have received less attention, and may arguably have longer-term impacts, particularly on subspecialty fields.[5]

On March 17, 2020 the Association of American Medical Colleges recommended a suspension of MS clinical rotations,[6] and on April 28, 2020 the Society for Neurologic Surgeons (SNS) 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 MS's (MS4's) training, and potentially be abbreviated in many MS3's training due to delays in medical school core rotations. Because of 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 acquisition[9] and clinical experience, and testing interests in various clinical subspecialties.[10, 11]

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

The need for greater subspecialty exposure, reported by MSs interested in neurosurgery, has been further amplified by the pandemic. 76% of MS3s report ≥1 cancelled or postponed neurosurgery rotation this year, and many MSs perceive a lack of readiness for neurosurgery residency applications.[16] In national surveys, MSs were more likely to take 1 year off from medical school after the start of the pandemic,[16] 1 in 3 MS1s were dissatisfied with neurosurgical career planning offered by their home medical school during the pandemic, and almost 1 in 5 MSs are now 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 MS1 and MS2), virtual surgical skills workshops (suggested by MS3 and MS4),[16] and focused webinars and conferences (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 training camp-style material to prepare for intern year, even in the absence of in-person gatherings.[5,17]

Responding to these pandemic-driven needs, the authors developed a cross-institutional virtually-compatible one-day training curriculum geared towards all levels of MSs.

Methods: Eight neurosurgery residency institutions (please see "Acknowledgements" section for full list) participated in a one-day virtual neurosurgery West Coast MS training camp from 8 AM to 2:30 PM (Pacific) on Saturday, June 13, 2020. Five institutions participated in the East Coast session which started three hours earlier than the West Coast session to account for time zone differences and to allow for greater national involvement. The West Coast program ended the day with a small-group virtual mentoring session between 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 large-scale mentoring sessions.

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

Results: 305 participants registered for the West Coast session. The distribution of MS by academic year is shown in Table 2. Of those registered, 108 (35.4%) students intend to apply to neurosurgery residency in the 2020-2021 National Resident Matching Program (NRMP) cycle (**Table 2**). Based on NRMP Match data from 2020, of 273 U.S. applicants to neurosurgery,[18] approximately 36.7% (100/273) of U.S. applicants that will be applying in the upcoming NRMP cycle registered for the West Coast session.

Throughout the course, there were a minimum of 203 participants total present on the virtual platform. Applicants for the upcoming 2020-2021 NRMP cycle were offered participation in a small group mentoring session comprised of 3-5 other MS applicants for this cycle, and one attending neurosurgeon. 102 (94.4%) registered MSs applying this NRMP cycle attended the small group mentoring session. 95 (31.1%) participants attended the breakout panel on "Women in Neurosurgery".

Among all MS participants, there were 165 unique institutions represented;107 (64.8%) U.S. medical schools, 9 (5.5%) U.S. osteopathic schools, and 49 (29.7%) international medical institutions. 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 attending neurosurgeons, 5 (19.2%) were chairs 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). Respondents were not required to answer all questions. All respondents (100%) indicated a future, annual virtual neurosurgery training camp should be held irrespective of COVID-19 limitations or a concurrent in-person event. The most commonly selected reason to continue a virtual format in the future was to increase participant access to content (82, 68.3%), followed by increased participating programs (80, 66.7%), and decreased cost (75, 62.5%) (**Fig. 1**). Unsolicited comments included that the virtual platform and flexible registration allowed for inclusion of international medical graduates, recent U.S. medical graduates or preliminary year residents interested in switching to neurosurgery, underrepresented minorities, and students with significant financial burdens or without a home neurosurgery program.

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

Regarding respondents' change in attitude towards neurosurgery after the event, on a scale of 1 (less enthusiastic) to 5 (more enthusiastic) 82.5% reported a score of 4 – 5 (more enthusiastic) (**Fig. 3A**). Free-text comments from two MS2s indicated that the participants were initially interested in pursuing other specialties, but after the event were more interested in neurosurgery than their previously intended subspecialty.

After the event, 79.8% of respondents' anxiety levels about the neurosurgery application and/or sub-internship process for the upcoming academic year decreased or greatly decreased (**Fig. 3B**). Participants were asked to rate their change in knowledge of neurosurgery after the event compared to before the event on a 5 point scale (1 = no change, 5 = greatly improved). A score of 4-5 was selected by 65.0% of respondents, 34.2% selected a score of 2-3, and 0.8% selected a score of 1 (**Fig. 3C**).

The highest rated sessions (not including the mentoring session for MS4s) were "What programs look for in an applicant" (panel of neurosurgery chairs), "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 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 in free-text comments. The virtual meet-and-greet was an open, unstructured virtual "room" that any student, 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 lasted for 2 hours with over 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 ways to improve the event in the future included lengthening the event, having more directed didactic sessions, and more advice on how to be an outstanding sub-intern or interviewee.

Discussion: The COVID-19 pandemic has turned much of academic medicine's educational focus to virtual platforms out of necessity. Though the shutdown of in-person medical education[19] and need for transitioning to virtual platforms[20] was tested in 2003 during the severe acute respiratory syndrome (SARS) pandemic, there have been great advancements in virtual education capabilities and greater public access to technology since that time. Neurosurgical societies have developed infrastructure to deliver high-quality interactive[21] 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.[24,25,26,27,28] However, there remained a paucity of instructional content pertaining to MS neurosurgical education, especially given MS's inability to conduct away sub-internships amidst COVID-19 in the U.S.[23]

In response to a demonstrated desire from MSs interested in neurosurgery to have: increased subspecialty contact, MS-specific neurosurgical didactic content, guidance on preparing for neurosurgery applications and sub-internships, and opportunities for mentorship and career planning, the authors 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 present the first nationally organized virtual conference subspecialty training camp for MSE.

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

The scalability and accessibility of a virtual event is 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/panelists. In 2019, between two institutions' in-person events there were 191 MS participants and 65 medical schools represented. At a single virtual session (West Coast only) there were 305 MS registrants and 43 neurosurgery program representatives; larger than the two prior in-person events combined.

One of the stated limitations of prior in-person training courses[14,15] was the overwhelming demand. While there are still technical challenges associated with increasing participant numbers even for virtual event platforms, content delivered directly to the participant's personal screen is easily visible, and a person's location is no longer a limitation so long as internet access is available; several panelists were able to dial in while at work, or while on vacation. While 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 a longer event, the relative ease of scalability on a virtual platform versus an in-person event could allow for a future multi-day 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 may be especially valuable given that evidence supports not only the benefits of early exposure to neurosurgery to help MSs determine their interest and skill within the specialty,[10,11] but can help undergraduates as well.[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.

While survey responses may have been limited by response bias (with respondents knowing that results may inform future neurosurgical education programming) and selection bias (as participants had a self-selected interest in attending a full day event about neurosurgery MS education), the authors note the overwhelming positive response rate (100%) to repeat this event in virtual format in the future.

Upon devising this course, one of the main limitations faced with the virtual platform compared to an in-person training camp was the inability to give direct feedback on manual technical skills due to the overwhelming participant to instructor ratio and inability to virtually share access to necessary supplies or equipment in their personal environment. However, one of the least common drivers for MS participation in these training camps was to bolster technical skills. The primary stated impetus from MSs to participate in the event was to gain "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 (either on sub-internships, through research opportunities, or during 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 MSs, we envision future offerings as a combination of virtual and in-person. This will utilize the strengths of each platform, maximizing access via a virtual environment while providing longer, more focused hands-on learning and lab 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 break down virtual barriers with integrated technologies, (such as real time polling, and "live operating rooms") virtual platforms may serve as the primary mode of desired content-delivery for such future events. It also democratizes access to content for MSs without a home neurosurgery program by providing a standardized, national neurosurgery sub-internship preparatory course.

Given the likely importance of subspecialty exposure to promote matriculation into other niche medical fields outside of neurosurgery, the authors offer 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 this virtual, standardized, national subspecialty training camp suggests that necessary COVID-19 driven innovations in MSE may 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 sub-internship process. This virtual training camp improves disease prevention, cost/resource conservation, and scalability compared to in-person training. This national virtual subspecialty training course may 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 may also help deliver standardized subspecialized content not often available through traditional medical curricula, especially to students in more resource-limited settings.

References

1. Amin-Hanjani S, Bambakidis NC, Barker FG, et al. Editorial. COVID-19 and neurosurgical practice: an interim report [published online ahead of print Apr 24, 2020]. *J Neurosurg*. 2020;1-2. doi:10.3171/2020.4.JNS201099
2. Clark VE. Editorial. Impact of COVID-19 on neurosurgery resident research training [published online ahead of print Apr 24, 2020]. *J Neurosurg*. 2020;1-2. doi:10.3171/2020.4.JNS201034
3. Alhaj AK, Al-Saadi T, Mohammad F, Alabri S. Neurosurgery Residents' Perspective on COVID-19: Knowledge, Readiness, and Impact of this Pandemic [published online ahead of print May 16, 2020]. *World Neurosurg*. 2020;S1878-8750(20)31058-5. doi:10.1016/j.wneu.2020.05.087
4. Rose S. Medical student education in the time of COVID-19 [published online March 31, 2020]. *JAMA*. doi:10.1001/jama.2020.5227
5. Garcia RM, Reynolds RA, Weiss HK, et al. Letter: Preliminary National Survey Results Evaluating the Impact of COVID-19 Pandemic on Medical Students Pursuing Careers in Neurosurgery [published online ahead of print May 9, 2020]. *Neurosurgery*. 2020;nyaa214. doi:10.1093/neuros/nyaa214
6. Association of American Medical Colleges Guidance on Medical Students' Participation in Direct Patient Contact Activities, April 14, 2020. https://www.aamc.org/system/files/2020-04/meded-April-14-Guidance-on-Medical-Students-Participation-in-Direct-Patient-Contact-Activities.pdf. Accessed April 21, 2020.
7. Society of Neurological Surgeons Policy on External Medical Student Rotations during the COVID-19 pandemic, April 28, 2020. https://www.societyns.org/medical-students/external-medical-student-rotations. Accessed June 13, 2020.
8. Lobel DA, Kahn M, Rosen CL, Pilitsis JG. Medical student education in neurosurgery: optional or essential?. *Teach Learn Med*. 2015;27(2):201-204.
9. Ferrel MN, Ryan JJ. The Impact of COVID-19 on Medical Education. *Cureus*. 2020;12(3):e7492.
10. Zuccato JA, Kulkarni AV. The impact of early medical school surgical exposure on interest in neurosurgery. *Can J Neurol Sci*. 2016;43(3):410-416.
11. Zuckerman SL, Mistry AM, Hanif R, et al. Neurosurgery elective for preclinical medical students: early exposure and changing attitudes. *World Neurosurg*. 2016;86:120-126.
12. Selden NR, Barbaro N, Origitano TC, Burchiel KJ. Fundamental skills for entering neurosurgery residents: report of a Pacific region "boot camp" pilot course, 2009. *Neurosurgery*. 2011;68(3):759-764.
13. Selden NR, Origitano TC, Burchiel KJ, et al. A national fundamentals curriculum for neurosurgery PGY1 residents: the 2010 Society of Neurological Surgeons boot camp courses. *Neurosurgery*. 2012;70(4):971-981.
14. Radwanski RE, Winston G, Younus I, et al. Neurosurgery Training Camp for Sub-Internship Preparation: Lessons From the Inaugural Course. *World Neurosurg*. 2019;127:e707-e716.
15. Radwanski RE, Winston G, Younus I, et al. Medical Student Neurosurgery Training Camp: Updates Following 2019 Course Expansion. *World Neurosurg*. 2019;130:561-563.
16. Guadix SW, Winston GM, Chae JK, et al. Medical Student Concerns Relating to Neurosurgery Education During COVID-19 [published online ahead of print May 16,

2020]. *World Neurosurg*. 2020;S1878-8750(20)31061-5. doi:10.1016/j.wneu.2020.05.090
17. Chae JK, Haghdel A, Guadix SW, et al. Letter: COVID-19 Impact on the Medical Student Path to Neurosurgery [published online ahead of print May 1, 2020]. *Neurosurgery*. 2020;nyaa187. doi:10.1093/neuros/nyaa187
18. National Resident Matching Program Advance Data Tables 2020 Main Residency Match. https://mk0nrmp3oyqui6wqfm.kinstacdn.com/wp-content/uploads/2020/03/Advance-Data-Tables-2020.pdf. Accessed June 9, 2020.
19. Clark J. Fear of SARS thwarts medical education in Toronto. *BMJ*. 2003;326(7393):784.
20. Patil NG, Chan Y, Yan H. SARS and its effect on medical education in Hong Kong. *Med Educ*. 2003;37(12):1127-1128.
21. Teton ZE, Freedman RS, Tomlinson SB, Linzey JR, Onyewuenyi A, Khahera AS, Hendricks BK, Cohen-Gadol AA: The Neurosurgical Atlas: Advancing neurosurgical education in the digital age. *Neurosurg Focus*. 2020;48: E17.
22. Tomlinson SB, Hendricks BK, Cohen-Gadol AA: Editorial. Innovations in neurosurgical education during the COVID-19 pandemic: is it time to reexamine our neurosurgical training models? *J Neurosurg*. 2020;1-2.
23. Dedeilia A, Sotiropoulos MG, Hanrahan JG, Janga D, Dedeilias P, Sideris M. Medical and Surgical Education Challenges and Innovations in the COVID-19 Era: A Systematic Review. *In Vivo*. 2020;34(3 Suppl):1603-1611.
24. Khalafallah AM, Jimenez AE, Lee RP, et al. Impact of COVID-19 on an Academic Neurosurgery Department: The Johns Hopkins Experience [published online ahead of print May 24, 2020]. *World Neurosurg*. 2020;S1878-8750(20)31138-4. doi:10.1016/j.wneu.2020.05.167
25. Carter BS, Chiocca EA. Editorial. COVID-19 and academic neurosurgery [published online ahead of print, 2020 Apr 17]. *J Neurosurg*. 2020;1-2.
26. Ozoner B, Gungor A, Hasanov T, Toktas ZO, Kilic T. Neurosurgery Practice During Coronavirus Disease 2019 (COVID-19) Pandemic [published online ahead of print, 2020 May 28]. *World Neurosurg*. 2020;S1878-8750(20)31166-9. doi:10.1016/j.wneu.2020.05.195
27. Eichberg DG, Shah AH, Luther EM, et al. Letter: Academic Neurosurgery Department Response to COVID-19 Pandemic: The University of Miami/Jackson Memorial Hospital Model. *Neurosurgery*. 2020;87(1):E63-E65.
28. Lewis CT, Zeineddine HA, Esquenazi Y. Challenges of Neurosurgery Education During the Coronavirus Disease 2019 (COVID-19) Pandemic: A U.S. Perspective [published online ahead of print, 2020 Apr 27]. *World Neurosurg*. 2020;138:545-547.
29. Burford C, Hanrahan J, Ansaripour A, et al. Factors Influencing Medical Student Interest in a Career in Neurosurgery. *World Neurosurg*. 2019;122:e367-e374.

Figure Legend:

Figure 1. Key drivers for medical students to continue a future annual training course in the virtual format irrespective of COVID-19 limitations and in-person capabilities.

Figure 2. Medical students' most important stated purposes of the training camp.

Figure 3. Changes in medical student A) perception, B) anxiety, and C) knowledge about neurosurgery after the virtual training course.

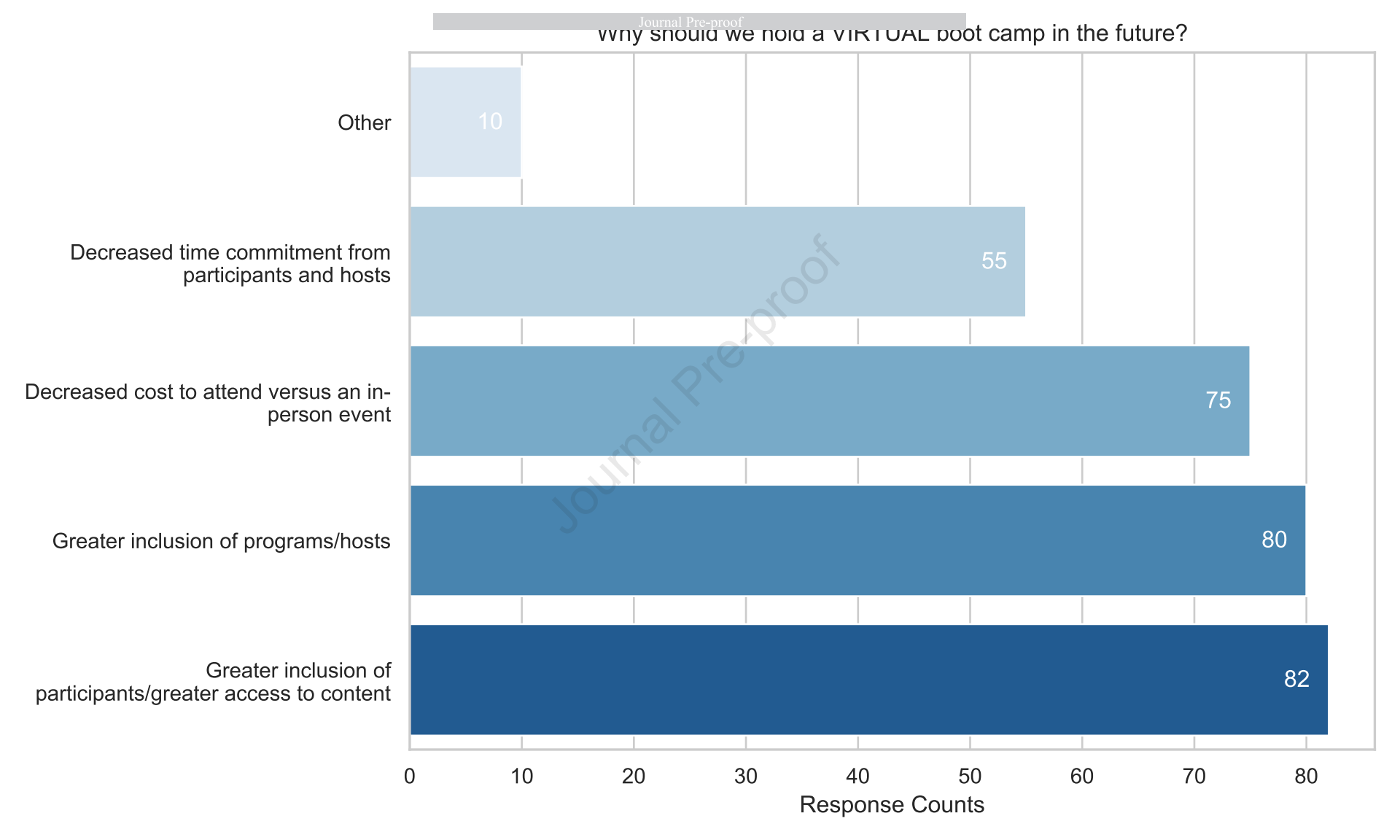
Tables:

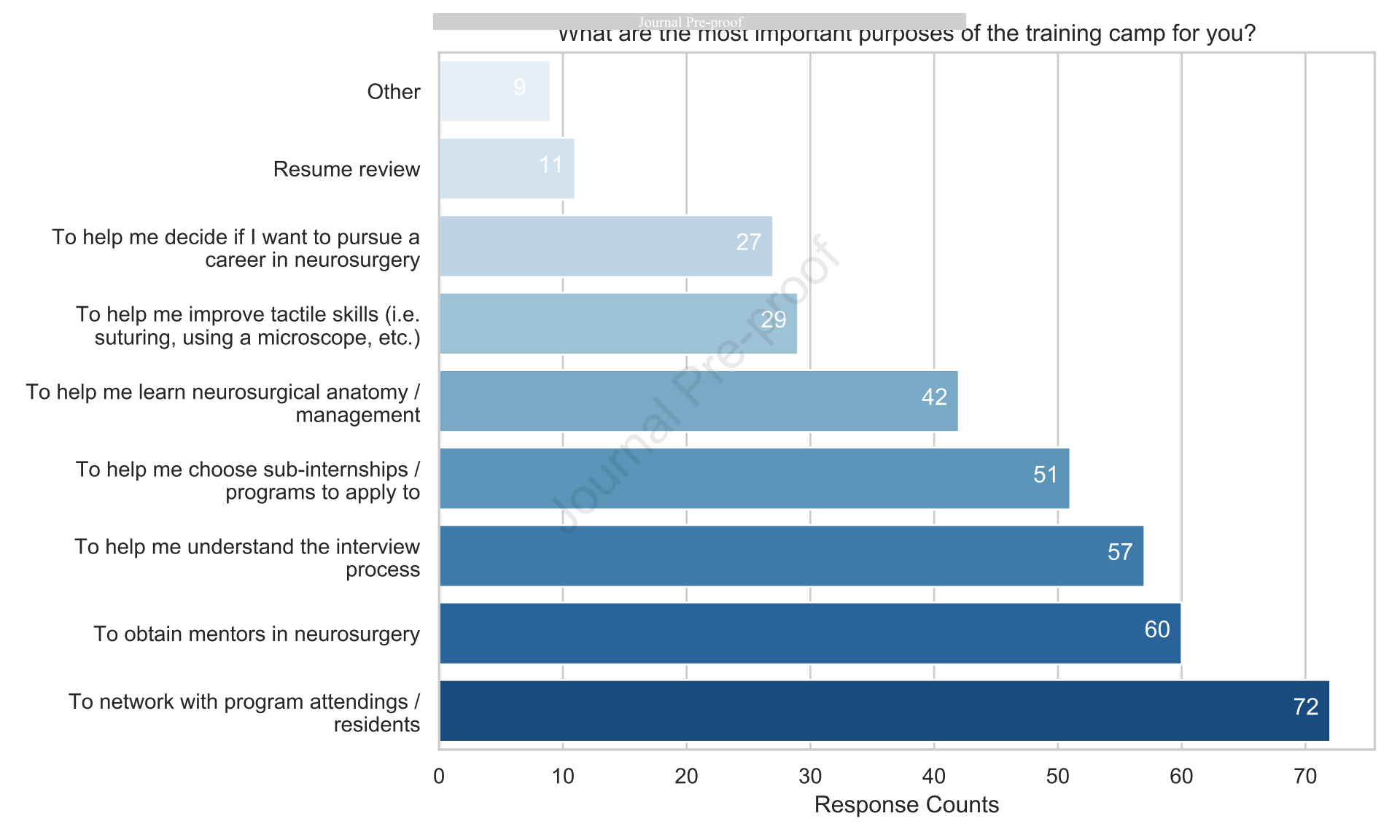
Table 1. Summary of West Coast Curriculum

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 Sub-Internship, Even During Covid-19.
Panel	What to Look for in Selecting a Residency Training Program.
Panel + Presentation	Research in Neuroscience and Neurosurgery.
Panel + 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).
Lab Presentation	Simple Cranial Dissection.
Small Group Presentation	Intracranial Pressure Management and Cranial Trauma
Small Group Presentation	Basic Neuronavigation Set Up, Common Instrument Names/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

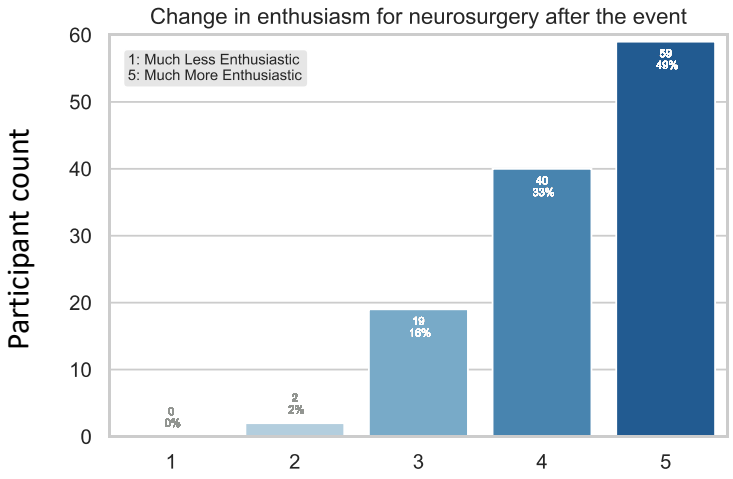
Table 2. West Coast Registrant Academic Demographics

Total West Coast Registrants	305
MS 1	63 (20.7%)
MS 2	32 (10.5%)
MS 3	52 (17.0%)
MS 4	86 (28.2%)
MD / PhD Candidate in their PhD years	37 (12.1%)
Other (International Medical Graduate, non-PhD research year/other degrees, recent graduate)	35 (11.5%)
Intend to apply for neurosurgery in the 2020-2021 National Residency Match (NRMP) cycle	108 (35.4%)
Intend to apply for the 2021-2022 NRMP Cycle	59 (19.3%)
Intend to apply for neurosurgery (non-identified NRMP cycle)	123 (49.3%)
No intentions of applying for neurosurgery residency	15 (4.9%)

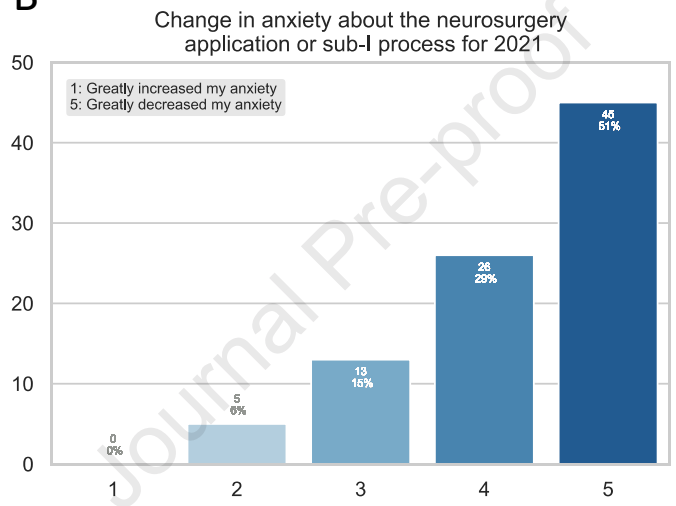




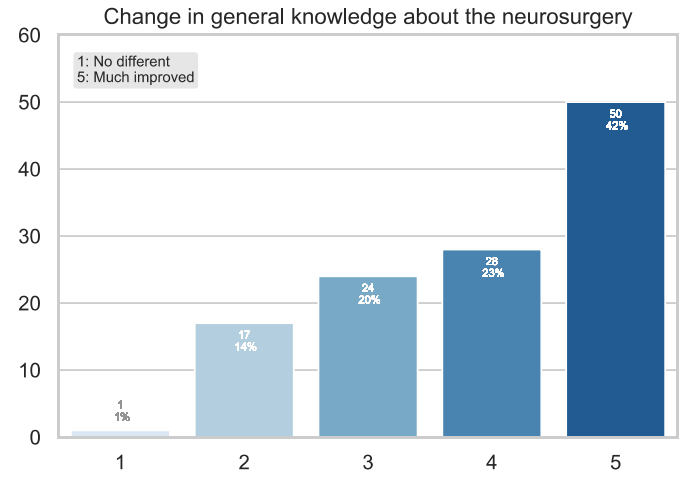
A



B



C



Abbreviations: coronavirus disease-19; COVID-19, medical student; MS, medical student education; MSE

Credit Author Statement

Jasmine A. Thum DiCesare - Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing

David Segar - Conceptualization; Data curation; Formal analysis; Software; Validation; Visualization; Roles/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

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: