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Neurosurgical Interactive Teaching Series: Multidisciplinary Educational Approach

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OBJECTIVE: **The goal of this manuscript is to investigate the effects of a multidisciplinary multinational web-based teaching conference on trainee education, research, and patient care.**

METHODS: **We present the structure, case selection, and presentation of our educational lectures. We retrospectively reviewed our database to gather data on the number of presentations, type of presentation, and the pathology diagnosis from November 11, 2016 until February 28, 2020. To investigate attendee satisfaction, we analyzed our yearly continuing medical education evaluation survey results to report the impact that this series may have had on our attendees. We assigned a numeric value to the answers, and the mean overall scores were compared through an analysis of variance. Further analysis on specific questions was performed with a Fisher exact test.**

RESULTS: **We have hosted 150 lectures, in which we have presented 208 neurosurgical cases corresponding to 133 general session, 59 pituitary, and 16 spine cases, as well as 28 distinct lectures by guest speakers from institutions across the globe. We received 61 responses to our yearly continuing medical education evaluations over the course of 3 years. On these evaluations, we have maintained an excellent overall rating from 2017–2019 (two-sided $P > 0.05$) and received significantly less suggestions to improve the series comparing 2017 with 2019 (two-sided, $P = 0.04$).**

CONCLUSIONS: **As the world of medicine is constantly changing, we are in need of developing new tools to enhance our ability to relay knowledge through accredited and validated methods onto physicians in training, such as the implementation of structured, multidisciplinary, case-based lectures as presented in this manuscript.**

INTRODUCTION

In 1919, Alfred W. Adson founded the neurosurgery department at the Mayo Clinic. However, his expertise was mostly related to general surgery. Despite being appointed to treat neurosurgical patients, he is noted to describe neurosurgery as a "hopeless field" due to the high mortality and morbidity associated with these procedures at that time.[1] Just a few years before the work of Dr. Adson (1904), Harvey Cushing was establishing neurosurgery as its own separate discipline.[2-6] Neurosurgery has since evolved from general surgeons taking care of neurosurgical patients to a completely separate entity with multiple subspecializations including vascular, functional, spine, pediatrics, and skull base.[7] As we advance medical knowledge, we strive toward the need to process an impressive amount of information limited to a single topic, leading to a subspecialization across all medical fields including neurosurgery.[7-9]

Furthermore, certain pathologic entities require multiple medical subspecialties to achieve the best patient care possible. It has been repeatedly shown that a multidisciplinary approach to patient care maximizes patient outcomes in multiple disciplines, and this holds true for neurooncology as well.[10-12] Similarly, in skull base surgery, resection of these tumors is an essential component of treatment, but a multispecialty team including neurosurgery, radiation oncology, neurooncology, neuropathology, and neuroradiology is needed to appropriately manage these patients.[12]

Institutions have established weekly multidisciplinary meetings in which complex cases are discussed to reach a consensus on how that specific case should be approached.[13,14] On the basis of a

Key words
- Education
- Lecture
- Multidisciplinary
- Neurosurgery residency
- Teaching series
- Trainees

Abbreviations and Acronyms
CME: Continuing Medical Education

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multidisciplinary approach, we created a separate weekly lecture format, which is broadcast internationally. Trainees are encouraged to critically prepare (with the help of multiple experts) and review surgical cases for educational purposes. In this multimedia format, the trainee is encouraged to use intraoperative videos to be able to tell a story where multiple groups get to comment and learn from including the junior and senior colleagues.

Technologic advances over recent years have had an impact on the way physicians are trained, shifting from practicing directly on the patient toward the use of indirect and simulated experiences to avoid harming the patient during their learning.[15-17] In this manuscript we present the structure of a new integrative, interactive, international, and multidisciplinary educational approach to neurosurgical cases (accredited by the Accreditation Council for Continuing Medical Education)[18] of patients who underwent care in our institution, as well as data from our experience since the series was established in November 2016.

METHODS

Structure of the Meeting

The neurosurgical teaching series lecture is held on a weekly basis. It is scheduled to last 1 hour, where 2 interactive cases are presented. The cases are led by our neurosurgery resident physicians, fellows, and trainees, who present at least once a month. The lecture is structured in a way that the presenter talks about the case as if he was the lead physician, promoting third order thinking skills. Physicians and surgeons who are involved in the care of the case are present for guidance and surgical rationale. Physicians who were not involved in the care of the presented case are also in the audience for questions and discussions.

To develop a multidisciplinary approach, members from the following specialties are present to enrich our discussion from different perspectives: neurosurgery, neurology, medical neuro-oncology, radiation-oncology, neuroradiology, neuropathology, otorhinolaryngology, neuropsychology, and endocrinology.

After the cases are presented, the audience engages in a discussion on the rationale that will be beneficial in the education of trainees. This is a real-time peer-reviewed discussion using scientific evidence from the literature, as well as experience from our institution.

Structure and Preparation of the Case Presentations

The structure of the case presentations is based on recommendations by the American Board of Neurological Surgery for case studies.[19] Cases are selected with 2 weeks in advance so that the presenter can properly prepare the case, have a thorough understanding, and review the presentation with the corresponding neurosurgery supervisor and all other physicians involved in care. Additionally, the neuropathology team prepares representative images of the histology studies performed on the tissue, and the neuroradiology team selects representative images from the diagnostic workup to make a comment on how the diagnosis was guided. These cases are selected to either have a high complexity or include surgical pearls and nuances to maintain our trainees up to date.

The presentations begin with the history of present illness and chief complaint including the evolution of the disease and symptomatology. Initial workup is then presented including laboratory values, imaging studies (e.g., magnetic resonance imaging, computed tomography scans, and conventional angiography) that are representative of the decision making process during surgical assessment based on case-specific characteristics. Presenters are encouraged to recognize important anatomic landmarks in these images. After the history, symptomatology, and diagnostic workup are presented, differential diagnoses are discussed with the audience, enlisting the most probable to the least probable. The final diagnosis is not disclosed with the audience to encourage third-order thinking. To enhance surgical education, a brief operative procedural video is presented. This video is 3–5 minutes long and includes positioning, surgical approach, surgical pearls, reconstruction, and closure. Postoperative hospital care and evolution are presented to evaluate acute complications related to the procedure. Postoperative follow-up with relevant laboratory values and imaging studies is also presented. This is followed by conclusions, where the presenter is encouraged to engage in critical thinking and comment on the obstacles that had to be overcome during patient care. To finalize the case, a brief review of the literature with the latest data is presented. The audience and presenter are then encouraged to engage in an active discussion about the nuances of the case (**Figure 1**).

Special Section: Pituitary, Spine, and Guest Speakers

Every 4 weeks our multidisciplinary neurooncology team holds a special pituitary section in which the endocrinology team leads the discussion about complex pituitary cases. These are copresented by both endocrinology and neurosurgery to provide a more thorough understanding of the hypothalamic-pituitary-end organ axes disrupted by these lesions.[20]

Although rare, spinal and medullary tumors arise and also need a multidisciplinary approach to their care.[21,22] Every 8 weeks, we hold a special spine section to discuss 2 challenging cases on spinal oncology.

Inclusion and Exclusion Criteria

We retrospectively analyzed our records of the multidisciplinary teaching series including the yearly report done to comply with the regulations for continuing medical education (CME). We analyzed previous presentations to review their diagnosis, which are presented in this paper. Presentations that were not available for retrospective review were not included in the analysis. To ensure patient confidentiality, the presentations are stored in a password-protected and encrypted drive for educational and research purposes, within the Mayo Clinic server. Informed consent for research and education was obtained for each case before presentation. No patient information, identity, or identifiers are disclosed during the presentations.

Continuing Medical Education Yearly Evaluation

After the end of every calendar year, our group surveys audience members from different disciplines to provide feedback about this academic activity. To obtain objective suggestions, these responses are anonymized. We reviewed the feedback reports for the years 2017, 2018, and 2019.

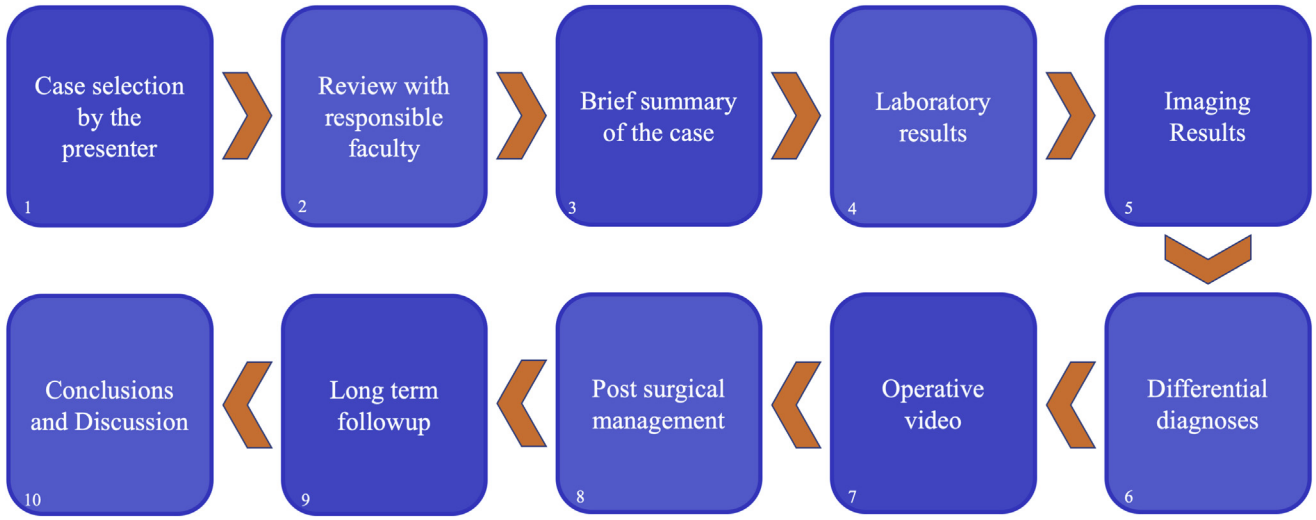

Figure 1. Presentation algorithm. Algorithm demonstrating the process for preparation of the case-based presentations at the Neuro-Oncology and Skull Base Teaching Series in our institution. This process is based on the recommendations by the American Board of Neurologic Surgery for case studies. Following these steps allows for a structured format that can be replicated on a weekly basis.

To assess whether there has been a change overall in the survey results over the course of our series, a 1-way analysis of variance with Tukey multiple comparisons was performed. To obtain the mean score of the survey we assigned a numerical value to the answers of every question as follows: Answers to questions 1, 5, and 6 included very deficient, deficient, good, very good, and excellent, and values from 0–4 were assigned, respectively. Answers to questions 2, 3, and 4 included unmet, partially met, and met, and values from 0–2 were signed, respectively. Answers to questions 7, 8, 9, and 10 included no or yes, and values from 0–1 were assigned, respectively. For question 11, we assigned a value of 2 for the answer "no changes needed" and no score for any other answer.

To evaluate the changes for each specific question, a Fisher exact test was performed. Only questions 1 and 11 were analyzed as they were the only questions with variation of the responses.

Statistical analysis was carried our using GraphPad Prism (Version 8 for Mac, GraphPad Software, San Diego, California, USA, www.graphpad.com). Questions and answers to the close-ended questions are summarized in Table 1.

RESULTS

Our Experience: Data from the Series

We analyzed our records from November 11, 2016 to February 28, 2020. Over this period, we have hosted a total of 150 meetings. A total of 208 cases has been presented, out of which 133 were general session cases, 59 were pituitary cases, and 16 were spine cases. We have also had 28 guest speakers from outside institutions who present about the novelties of their surgical practice and research.

For data representation, we divided the data as follows. For regular sessions (Figure 2), cases were divided into gliomas (n = 40), meningiomas (n = 26), metastasis (n = 13), schwannomas (n = 8), vascular lesions (n = 19), unspecified lesions (n = 3), and other lesions or procedures (n = 24).

For our special pituitary section (Figure 2), cases were divided into pituitary adenomas (n = 43), which included somatotroph type, gonadotroph type, corticotrope type, and nonfunctioning type; craniopharyngiomas (n = 6); and other lesions, which included germinomas (n = 2), meningiomas (n = 2), metastasis from a liver primary (n = 1), oligodendroglioma (n = 1), adrenalectomy (n = 1), Rathke cleft cyst (n = 1), and pituitary apoplexy (n = 1).

For our special spine section, cases were divided into these tumors: schwannoma (n = 2), metastatic lesions (n = 3), meningioma (n = 2), hemangioblastoma (n = 1), hemangiopericytoma (n = 1), chordoma (n = 1), and unspecified lesions (n = 3).

Continuing Medical Education Yearly Evaluation

The total survey participants were n = 17 (2017), n = 26 (2018), and n = 18 (2019) for a total of 61 answers. These participants included attending physicians (n = 34), nursing staff (n = 6), residents (n = 13), research staff (n = 5), and other (n = 3).

Over 86.9% of the total survey answers for question 1 rated the lectures overall as "excellent" (maximum rating), while the rest (13.1%) rated it as "very good"; no answers were recorded for the rest of the categories (good, bad, very bad). Objectives 1 and 2 were recorded as "met" on the 100% of the survey results, while 96% recorded objective 3 as "met" with only 1 response as "partially met"; no responses were recorded as "unmet." For presenter skills in 2018, 73.1% of the responses recorded them as

Table 1. Summary of the Questions and Responses From the Yearly Continuing Medical Education Survey by the Attendees

Questions and Objectives	Answer	Year (%)		
		2017 (n = 17)	2018 (n = 26)	2019 (n = 18)
1. Overall, how would you rate this activity?	Excellent	16 (94.1)	22 (84.7)	15 (83.3)
	Very good	1 (5.9)	4 (15.4)	3 (16.7)
2. Objective 1: Describe the diagnostic approach to tumors of the brain, spinal cord, and peripheral nervous system.	Met	17 (100)	26 (100)	18 (100)
3. Objective 2: Identify new neuro-oncology knowledge, clinical trials, cancer biology, and new treatment trials.	Met	17 (100)	26 (100)	18 (100)
4. Objective 3: Outline different options for neuro-oncology treatment including corticosteroids, immunotherapy, chemo and nanomedicine therapy, radiotherapy, and neurosurgery.	Met	17 (100)	25 (96.2)	18 (100)
	Partially met	0	1 (3.8)	0
5. Presenter's presentation skills	Excellent	N/A	19 (73.1)	15 (83.3)
	Very good	N/A	6 (23.1)	3 (16.7)
	Good	N/A	1 (3.8)	0
6. Presentation's value content	Excellent	N/A	21 (80.8)	15 (83.3)
	Very good	N/A	5 (19.2)	3 (16.7)
7. Were evidence-based references incorporated when appropriate?	Yes	17 (100)	26 (100)	18 (100)
8. This activity was free of commercial bias or influence.	Yes	17 (100)	26 (100)	18 (100)
9. I would recommend this activity to others.	Yes	17 (100)	26 (100)	18 (100)
10. The content of this activity matched my current (or potential) scope of practice.	Yes	17 (100)	26 (100)	18 (100)
11. The format of this educational activity can be improved by: (select all that apply)	No changes needed	12 (54.5)	18 (69.2)	14 (87.5)
	Include more case-based presentations	3 (13.6)	3 (11.5)	1 (6.3)
	Increase interactivity with participants	3 (13.6)	3 (11.5)	1 (6.3)
	Increase Q&A time	4 (18.2)	2 (7.7)	0

N/A, data were unavailable for this section. The answers that were not recorded in the survey results were not included in the summarized table. Answers to questions 1, 5, and 6 included excellent, very good, good, bad, and very bad. Answers to questions 2, 3, and 4 included met, partially met, and unmet. Answers to questions 7, 8, 9, and 10 included: yes or no.

"excellent" while the rest classified them as "very good"; in 2019 we saw an increase in ratings to a recorded 83.3% rating them as "excellent"; we had no recorded answers for the rest of the categories. Furthermore, 100% of the survey responders found a positive impact of these lectures on their clinical practice and would recommend them to their colleagues. When asked if they would recommend any changes to the structure (question 11), in 2017, 54.5% of the survey responders recorded their answer as "no changes needed; this percentage raised to 69.2% in 2018 and 87.5% in 2019.

There was no significant change in the overall survey results from 2017 to 2019 (2017 vs. 2019, mean score = 18.49, P = 0.70), (2017 vs. 2018, mean score = 26, P = 0.75), and (2018 vs. 2019, mean score = 26.37, P = 0.99). While comparing question 1 separately, no significance was found across the 3 years; 2017 versus 2019 (two-sided, 94.1% excellent and 5.9% not excellent responses in 2017 vs. 83.3% and 16.7% not excellent responses in 2019, P = 0.60); 2017 versus 2018 (two-sided, 94.1% and 5.9% vs. 84.7% and 15.4%, P = 0.63); 2018 versus 2019 (two-sided, 84.7% and 15.4% vs. 83.3% and 16.7%, P > 0.99) (Figure 3). While comparing question 11 separately, a significance was found when comparing the year 2017 to the year 2019 (two-sided, 54.5% no changes needed responses and 45.5% other responses in 2017 vs. 87.5% no changes needed responses and 12.5% other responses in 2019, P = 0.04), and no significance was found when comparing year 2017 with year 2018 (two-sided, 54.5% and

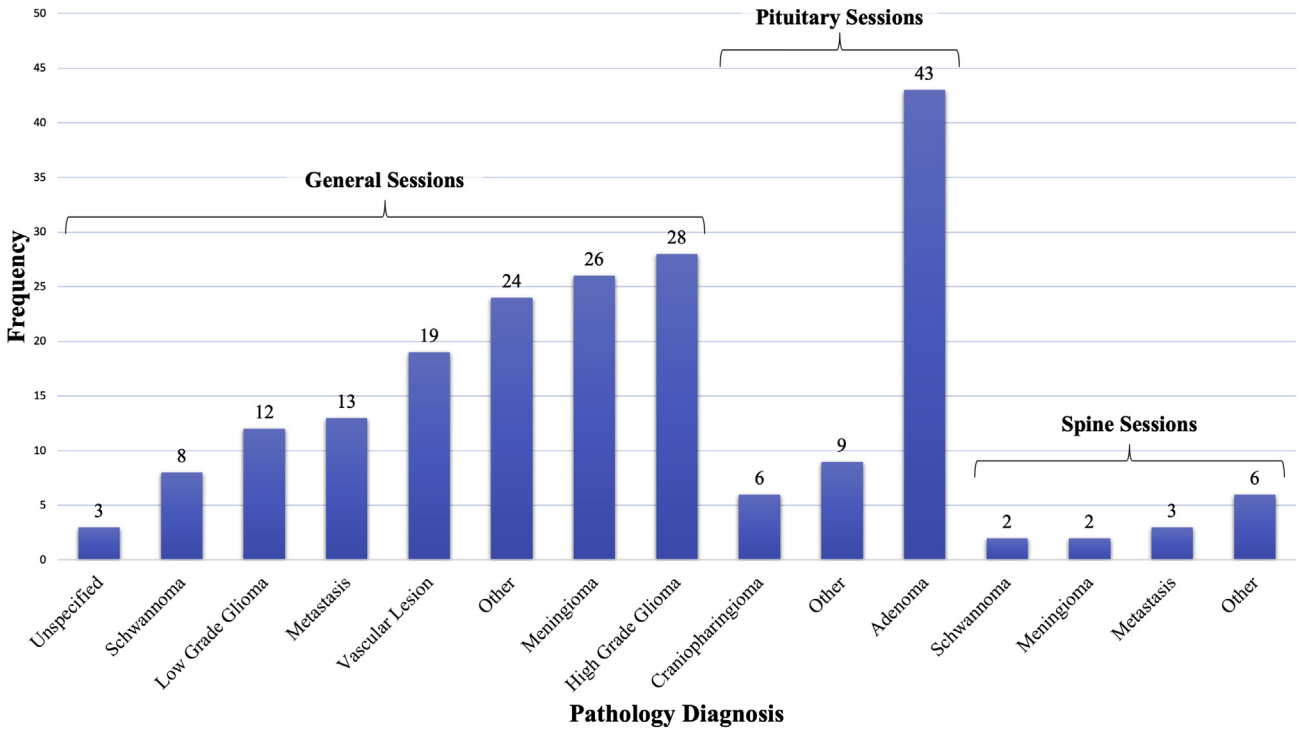

Figure 2. Frequency of pathology diagnoses presented in our educational series. Bar chart showing the frequency distribution of the cases presented in the neurosurgical lecture series over the past 3 years in our institution. A total of 150 sessions have been held, with 208 cases presented from November 11, 2016 to February 28, 2020. These sessions include our general sessions, as well as our special monthly pituitary and spine sessions.

45.5% vs. 69.2% and 30.8%, $P = 0.37$) or year 2018 to year 2019 (two-sided, 69.2% and 30.8% vs. 87.5% and 12.5%, $P = 0.27$) (Figure 4).

Adaptability: Going Beyond the Limits

Even though the topics discussed in the lectures are focused on neurosurgical topics, the format of the presentations allows for any health care professional, ranging from technicians to fully trained faculty. This is due to the recurring specific structure that can be applied to any medical field or specialty, allowing any-level health professional to develop an ordered rationale and third-order thinking. By directing to any type of health worker, we allow the lectures to have a larger audience.

There is an even larger opportunity of further increasing the audience. The idea arose to adapt our lectures for regulations during the COVID-19 pandemic.[23-29] To cope with the CDC guidelines,[30] our group transferred live presentations to video conferences (ZOOM Video Communications [2020], San Jose, California, USA.). By adapting our lectures into a video chat format, we realized we could extend the outreach to international audience.

It is important to be certain that the case studies do not contain patient identifiers. Furthermore, participants and audience need to agree and sign an informed consent as their voices can be revealed during the publication of the lectures; this can be done digitally.

Briefly, our group has been able to reach different sites within the United States, as well as international sites in Latin America and Europe, reaching over 150 physicians including their own teams of trainees and faculty.[31]

DISCUSSION

Current Challenge of Neurologic Surgery Training

The introduction of technology into the medical field has shifted the way junior physicians are trained, shifting from training directly on the patient toward simulated experiences.[16,17,32-35] Therefore residency programs have been adapting and developing new educational techniques[36] through the use of simulators[37-40] and, as presented in this manuscript, educational lectures.

There have been results on the variability of attention span in humans and its relationship with different types of stimulus.[41] Our group has tried to account for these factors by including multimedia elements, such as imaging and short surgical videos into the presentations and frequent interaction between attendees. In this manuscript we present a CME-accredited, recurring, international lecture series for medical trainees from

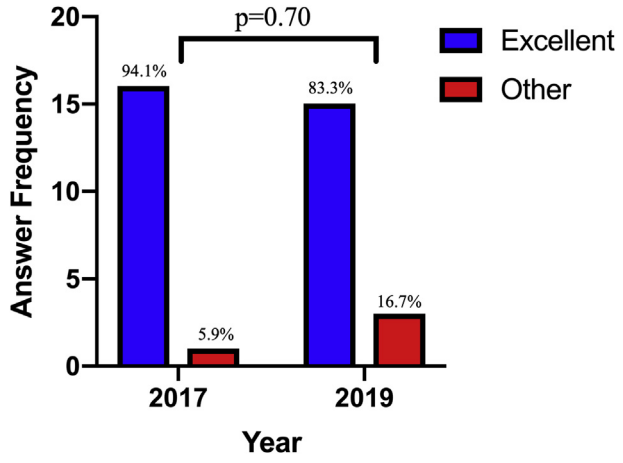

Figure 3. Analysis of Answers to Question 1 of the yearly CME evaluation: Overall how would you rate this activity? Multiple comparison bar chart showing the answers for Question 1 of the yearly CME assessment survey completed by our attendees: "Overall, how would you rate this activity?" No significance was found when comparing the answers from 2017 to 2019, suggesting a stable excellent subjective rating over the course of the study.

all levels of education that has been shown to have a direct impact on patient care.

A multidisciplinary approach toward patient care is essential to achieve optimal outcomes in neurooncologic patients.[10,11,42-45] Many institutions including our own have implemented a weekly multidisciplinary conference, commonly known as a *multidisciplinary tumor board*, where complex cases from the practice are discussed to reach an integrative approach toward treatment.[13,14,46] Recent studies have surged about the importance and benefits of these multidisciplinary meetings, further highlighting the importance of this approach to patient care.[47-49] Due to the growing evidence, our group decided to establish a weekly educational series for our young surgeons. We believe that a multidisciplinary form of care must be integrated to the education of every surgical trainee, as early understanding of its benefits will be beneficial to the care delivered by them.

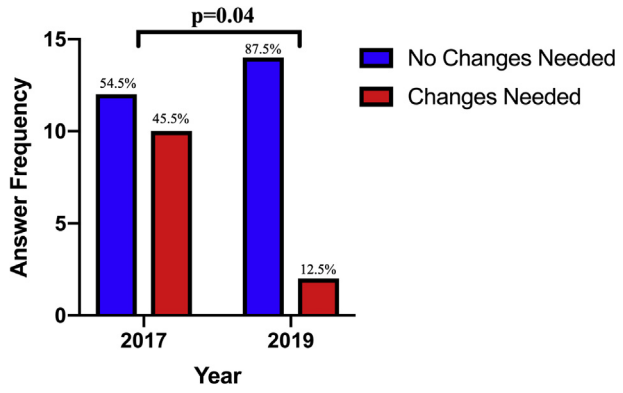

Figure 4. Analysis of Answers to Question 11 of the yearly CME evaluation: The format of this educational activity can be improved by … . Multiple comparison bar chart showing the answers for Question 11 of the yearly CME assessment survey completed by our attendees: "The format of this educational activity can be improved by … ." Significance was found while comparing 2017 with 2019 (two-sided, $P = 0.04$), suggesting an improvement of the format over the past 3 years.

Our Response to the Challenge

To the best of our knowledge, this is the first manuscript to describe an established multidisciplinary interactive lecture series, organized and presented by medical trainees that is held on a weekly basis. We present how a structured meeting can be effectively held in the benefit of residents and attendings. We also present data on the type of lesions that are chosen for presentation, which are mostly skull base tumors. This is probably due to the tenacity of the cases that are chosen for presentation as they require a multispecialty team.[10-12] We believe that this educational tool will have a positive impact in the career of our young residents, and as such we are enthusiastic to share our methods with other training programs.

Our educational method is based on the well-established case-based learning technique, where the trainees are encouraged to actively learn through real cases.[50] To enhance this technique, our group adapted the presentations to include a surgical video, prepared by the trainee, with the key portions of the procedure. This way our trainee obtains surgical and anatomic training through a simulation. Furthermore, engaging in a multidisciplinary discussion allows for a more holistic approach where different points of care are discussed.

The overall satisfaction level has been maintained as "excellent" throughout the past 3 years as reflected in our analysis. Even though in the year 2019 we obtained less "excellent" responses than the previous 2 years, the difference was nonsignificant. We believe that this is possibly due to the responses consistently falling within the maximal values throughout the study period; therefore any small variation within the responses will not affect the significance. The decrease in these responses may be due to the variability of the attendees answering the survey as they may be different between the years, as well as a minimal difference in the definition between "very good" and excellent." Moreover, on analysis of question 11 we see a significant improvement in the feedback, with a significant increasing number of answers recommending no further changes to the format, suggesting that our attendees are satisfied with how the meeting is carried out.

By creating a case review within a multidisciplinary setting, like the one we present in this paper, we take medical education one step further by allowing our trainees to develop a framework of how to critically think through complex cases and receive real-time feedback from international experts as they present.

LIMITATIONS

This is a study representing the data that we have collected from our weekly multidisciplinary lecture series. It was done at a single

institution with a single multidisciplinary team within a single-residency program. Studies within our institution, as well as multicenter studies, are needed to validate our data, as well as the efficacy and impact that these meetings have in the education of young physicians.

There are inherited limitations in this study as it is retrospective and survey based in nature. These include sampling error and recall bias. As the survey results are anonymous and blinded, it gives us the opportunity for future feedback. Even though this study has its strengths and limitations, it can provide a baseline for future manuscripts in order to improve medical education.

CONCLUSION

As the world of neurosurgery is constantly changing, we are in need of developing new tools to enhance our ability to relay knowledge through accredited and validated methods onto physicians in training, such as the implementation of structured, multidisciplinary, case-based lectures as presented in this manuscript. We encourage the community to share their experience to further enhance the future of medical education.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Andres Ramos-Fresnedo: Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization, Formal analysis, Writing - original draft. **Ricardo A. Domingo:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization, Writing - original draft. **Karim ReFaey:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **Kelly Gassie:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **William Clifton:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **Sanjeet S. Grewal:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **Selby G. Chen:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **Kaisorn L. Chaichana:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization. **Alfredo Quiñones-Hinojosa:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - review & editing, Visualization, Supervision.

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