



Experimental Research

Advancing neurosurgery education in junior doctors and medical students – A neurosurgery virtual lecture series

Jing Xian Lee^{a,*}, Ish Ahmed^b^a Department of Medical Education, University Hospital of North Tees, Hardwick Road, Stockton-On-Tees, TS19 8PE, United Kingdom^b Department of General Surgery, University Hospital of North Tees, Hardwick Road, Stockton-On-Tees, TS19 8PE, United Kingdom

ARTICLE INFO

Keywords:

Medical education

Neurosurgery

Virtual learning

ABSTRACT

Background: Exposure to neurosciences, especially neurosurgery, in UK medical schools is limited and variable. This combined with the fact that neurology and neurosurgery have been perceived as notoriously difficult subjects could negatively affect confidence and efficiency in junior doctors when assessing and managing patients with neurosurgical conditions. This study aims to assess the impact of a neurosurgery virtual lecture series on foundation doctors' and medical students' confidence and knowledge in the assessment and management of neurosurgical patients.

Methods: Six virtual lectures were delivered via Zoom weekly between October and November 2020 covering lesion localisation, neuroradiology, neurosurgical emergencies, trauma assessment, and neuro-ICU. Data was collected relating to participants' pre- and post-lecture self-perceived confidence levels and performance of five SBA questions, lecture series satisfaction, and feedback.

Results: 31 participants in a district general hospital attended the virtual lecture series (17 foundation doctors and 14 medical students). Pre-lecture, foundation doctors felt significantly more confident than medical students in trauma assessment, spinal emergencies and neurointensive care medicine. In all lectures, participants' median confidence levels improved significantly post-lecture ($p < 0.05$). There was no significant difference in the performance of pre-lecture SBA questions between foundation doctors and medical students in all but one lecture, which was the neuro-ICU lecture where foundation doctors scored better (3.0 vs 1.0, $p = 0.012$). In both cohorts, the participants' median scores in SBA questions (objective marker of knowledge improvement) increased significantly post-lecture in all lectures.

Conclusion: This study has shown that this neurosurgery virtual lecture series that was focused and low-cost was well received, improved knowledge and confidence of junior doctors and medical students in assessing and managing neurosurgical patients. Future expansion of this lecture series into regional or national initiative can further increase exposure to neurosurgery, ultimately improving the care of neurosurgical patients.

1. Introduction

Exposure to neurosciences, especially neurosurgery, in medical schools in the United Kingdom (UK) is limited and varies across the country [1,2]. Surveys conducted in Ireland and the United States (US) indicate similar concerns [3,4]. This combined with the fact that neurology and neurosurgery have been perceived as notoriously difficult subjects could negatively affect confidence and efficiency in junior doctors when assessing and managing patients with neurosurgical conditions [5,6]. Moreover, neurosurgery rotations in the UK Foundation Programme (the equivalence of internship in the US) are very rare hence

there could be a deficiency in knowledge especially in junior doctors working in non-tertiary district general hospitals where it is not an in-house specialty.

The COVID-19 pandemic has caused severe disruption to medical education in many parts of the world, affecting not only medical students and junior doctors but also senior trainees [7] and unfortunately neurosurgical education was not spared as shown by a survey done by Guadix et al. highlighting medical students' concerns regarding their neurosurgery education during this pandemic [8].

To respond to this challenge, many new educational initiatives and programmes have been designed globally to maintain medical education

* Corresponding author.

E-mail address: j.lee17@nhs.net (J.X. Lee).<https://doi.org/10.1016/j.amsu.2021.102578>

Received 30 May 2021; Received in revised form 15 July 2021; Accepted 15 July 2021

Available online 16 July 2021

2049-0801/© 2021 The Authors. Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

during this difficult time at both undergraduate and postgraduate levels [7,9]. One of the most popular solutions include running courses and teaching programme virtually using novel video conferencing tools such as Microsoft Teams (Microsoft Corporation, Redmond, Washington) and Zoom (Zoom Video Communications, San Jose, California).

This paper aims to firstly assess the impact of a multi-session, near-peer led neurosurgery virtual lecture series on foundation doctors' and medical students' self-perceived confidence and knowledge in the assessment and management of patients presenting with common neurosurgical conditions and, secondly, to demonstrate the feasibility of running a virtual lecture series as an effective educational tool for teaching especially when face-to-face sessions are discouraged due to social distancing measures during the COVID-19 pandemic.

2. Methods

2.1. Study population

A series of six virtual lectures was delivered via Zoom weekly between October and November 2020 for Foundation Year (FY) doctors (first and second year post-graduation from medical school) and senior medical students (fourth and fifth years) working or undertaking a placement in a district general hospital respectively.

The teaching faculty consisted of junior doctors either working in the specialty of their lecture topic or those having a special interest in their lecture topic with a mix of registrars (residents) and senior house officers, namely neurosurgery and neuroradiology registrars, surgical specialty trainee, anaesthetic clinical fellow and an FY2 doctor with an interest in neurosurgery.

The neurosurgical topics were selected based on prevalence of conditions and relevance to FY doctors and senior medical students collectively by the whole teaching faculty followed by approval from the teaching programme supervisor. Each lecture lasted for an hour and the titles are as below:

- Lecture 1: Localising the lesion in the neural axis
- Lecture 2: Approach to assessing and managing trauma patients
- Lecture 3: Neuroimaging crash course for non-radiologists
- Lecture 4: Neurosurgical emergencies part 1: intracranial bleeds
- Lecture 5: Neurosurgical emergencies part 2: spinal and other emergencies
- Lecture 6: Neurointensive care medicine

The lectures were recorded with permission from the speakers and shared with all participants who signed up for the lecture series to recap or go through if for any reason they were not able to attend the live weekly stream (for example due to on call commitments) to maximise the engagement and coverage of this lecture series.

All participants were requested to complete a pre-and post-lecture questionnaire for each lecture they attended. The pre-lecture questionnaire consisted of participants' stage of training or study, confidence levels in assessing and managing neurosurgical patients based on the topic of each lecture, any particular subject they want the speaker to cover in the lecture topic and five single best answer (SBA) questions. The post-lecture questionnaire again collected information on confidence levels post-lecture, repeat of the five SBA questions and general feedback for the lecture and speaker. The SBA questions were directly related to the presentation delivered. Confidence levels were assessed using a 5-point Likert scale. (1 = no confidence, 2 = slight confidence, 3 = indeterminate, 4 = fairly confident, 5 = complete confidence).

The main outcomes of this study were self-perceived confidence levels pre-vs post-lecture, knowledge improvement in neurosurgical topics (measured by scores of SBA questions pre-vs post-lecture), satisfaction of lecture series and feasibility of running a virtual lecture series.

2.2. Statistical analysis

All data were collected and anonymised data recorded into an encrypted Excel® database (Microsoft, Redmond, WA, USA). The pre-and post-lecture confidence levels Likert scores and SBA questions performance (as an objective measure of knowledge improvement) both of which are continuous variables were presented as median (interquartile range) and compared using the Wilcoxon matched-pairs Signed-Rank Test. The pre-lecture perceived confidence level Likert scores and SBA questions scores were also compared between the two cohorts of participants (FY doctors and medical students) using Mann-Whitney *U* test. A *p* value < 0.05 was considered significant and all statistical tests were performed using SPSS® Statistics 25 (IBM Corp., Armonk, NY, USA).

2.3. Ethics and consent

Participants were informed and consented for the data collected in the pre- and post-lecture questionnaires to be anonymised and analysed for research and publication in scientific journals. The study was carried out in line with the requirements of the Declaration of Helsinki.

3. Results

3.1. Study population

A total of 55 participants signed up to the virtual lecture series but only 31 participants (9 FY2 and 8 FY1 doctors, 1 fifth year and 13 fourth year medical students) were included in the final study after meeting the requirement of attendance to one or more lectures and submission of both the pre- and post-lecture questionnaires. All the FY doctors were working in the same district general hospital and all the medical students were from the same university.

3.2. Confidence level

Table 1 shows the median self-perceived pre-lecture confidence levels of the participants. FY doctors felt significantly more confident than medical students in the areas of trauma assessment and management, spinal neurosurgical emergencies, and neurointensive care medicine.

In all of the six lectures, participants' median confidence levels improved significantly post-lecture compared to pre-lecture (*p* < 0.05) as shown in Table 2.

3.3. Knowledge assessment

There was no significant difference in the performance of pre-lecture

Table 1

Median confidence levels in participants pre-lecture (FY doctors compared with medical students).

Lecture	FY Doctors (n = 17)	Med students (n = 14)	Overall (n = 31)	<i>p</i> - value
Localisation of lesion	2.0 (2.0–2.0)	2.0 (2.0–3.0)	2.0 (2.0–3.0)	0.710
Assessment of trauma patient	2.0 (2.0–3.0)	1.5 (1.0–2.0)	2.0 (1.0–2.0)	0.026
Neuroradiology	2.0 (1.0–3.0)	2.0 (2.0–2.75)	2.0 (1.0–3.0)	0.739
Neurosurgical Emergencies Part 1	2.0 (2.0–3.0)	1.5 (1.0–2.0)	2.0 (1.0–2.0)	0.071
Neurosurgical Emergencies Part 2	2.0 (2.0–2.0)	1.0 (1.0–1.0)	1.0 (1.0–2.0)	0.003
Neurointensive Care	2.0 (1.0–2.0)	1.0 (1.0–1.0)	1.0 (1.0–2.0)	0.009

*values displayed are median (interquartile range). Mann-Whitney *U* test for difference.

Table 2

Confidence levels in participants pre- and post-lecture (FY doctors and medical students combined).

Lecture	Pre-lecture	Post lecture	p-value
Localisation of lesion (n = 18)	2.0 (2.0–3.0)	3.5 (2.75–4.0)	0.002
Assessment of trauma patient (n = 19)	2.0 (1.0–2.0)	3.0 (3.0–4.0)	<0.001
Neuroradiology (n = 21)	2.0 (1.5–2.5)	3.0 (3.0–4.0)	0.002
Neurosurgical Emergencies Part 1 (n = 13)	2.0 (1.0–2.0)	4.0 (3.5–4.0)	0.001
Neurosurgical Emergencies Part 2 (n = 17)	1.0 (1.0–2.0)	3.0 (2.5–4.0)	<0.001
Neurointensive Care (n = 15)	2.0 (1.0–2.0)	3.0 (3.0–4.0)	0.001

*values displayed are median (interquartile range). Wilcoxon matched-pairs Signed-Rank Test for difference.

SBA questions between FY doctors and medical students in all but one lecture, which was the neurointensive care lecture where FY doctors scored better (3.0 vs 1.0, $p = 0.012$, Table 3).

The participants' median scores in SBA questions (as an objective marker of knowledge improvement) increased significantly post-lecture in all six lectures in both study cohorts (Table 4).

3.4. Lecture series satisfaction

100% of participants (n = 31) would recommend this neurosurgery virtual lecture series to their colleagues. 100% of participants would be happy for further lecture series to be run virtually on similar video conferencing software. The comments in the free-text boxes for any particularly positive feedback and suggestions to improve the current or future lecture series are shown in Appendix 1.

4. Discussion

To the best of our knowledge, this is the first neurosurgery virtual lecture series to be run via an online meeting platform for a mixed audience of FY doctors and medical students, hosted at a single UK hospital. This pilot virtual lecture series was well received amongst the participants with satisfactory attendance despite being run out-of-hours on weekday evenings over the course of six weeks, indicating keen interest in learning more about neurosurgery which is supported by studies looking at neurosurgery education in the UK [1,2]. This is further supported by the fact that 100% of the participants would recommend this virtual lecture series to their peers and also attend similar virtual

Table 3

Median scores of SBA questions in participants pre-lecture (FY doctors compared with medical students).

Lecture	FY Doctors	Med students	Overall	p-value
Localisation of lesion (n = 18)	1.5 (0.0–2.0)	2.0 (1.25–3.0)	2.0 (0.0–3.0)	0.237
Assessment of trauma patient (n = 19)	3.0 (3.0–3.0)	2.5 (1.25–3.0)	3.0 (1.0–3.0)	0.905
Neuroradiology (n = 21)	1.0 (1.0–2.0)	1.0 (1.0–1.0)	1.0 (1.0–2.0)	0.602
Neurosurgical Emergencies Part 1 (n = 13)	2.0 (1.5–2.0)	1.5 (1.0–2.0)	2.0 (1.0–2.0)	0.836
Neurosurgical Emergencies Part 2 (n = 17)	2.0 (2.0–2.0)	2.0 (0.5–2.0)	2.0 (1.0–2.0)	0.277
Neurointensive Care (n = 15)	3.0 (2.0–4.0)	1.0 (1.0–1.0)	2.0 (1.0–3.0)	0.012

*values displayed are median (interquartile range). Mann-Whitney *U* test for difference.

Table 4

Median scores of SBA questions in participants pre- and post-lecture (FY doctors and medical students combined).

Lecture	Pre-lecture	Post lecture	p-value
Localisation of lesion (n = 18)	2.0 (0.0–3.0)	4.0 (2.0–5.0)	0.001
Assessment of trauma patient (n = 19)	3.0 (1.0–3.0)	4.0 (3.0–5.0)	0.004
Neuroradiology (n = 21)	1.0 (1.0–2.0)	3.0 (2.0–4.0)	<0.001
Neurosurgical Emergencies Part 1 (n = 13)	2.0 (1.0–2.0)	3.0 (3.0–4.0)	0.002
Neurosurgical Emergencies Part 2 (n = 17)	2.0 (1.0–2.0)	3.0 (2.5–4.0)	<0.001
Neurointensive Care (n = 15)	2.0 (1.0–3.0)	4.0 (3.0–5.0)	0.001

*values displayed are median (interquartile range). Wilcoxon matched-pairs Signed-Rank Test for difference.

lecture series in other teaching subjects in the future. The ability to record these virtual lecture series and access these from the archive for participants to review meant that learning was made more flexible and self-directed. A similar neurosurgery postgraduate educational programme for residents was reported by Kemp et al. in the US with good success [10].

We found that the confidence level in FY doctors and senior medical students in assessing and managing neurosurgical patients were low with the median score of slight confidence or no confidence at all respectively. This is in keeping with the finding of a study by Skarparis et al. which reported that 33.3% of UK final-year students had difficulty in identifying patients that require neurosurgical referral [11]. This is an alarming finding given the fact that annually 1.4 million people attend emergency departments in England and Wales with head injury and about 200,000 people are admitted to hospital as a direct consequence. Of these, one-fifth have features suggestive of skull fracture or evidence of brain damage and head injury remains the most common cause of death under the age of 40 years in the UK [10].

Despite having a higher self-perceived confidence level in the topics of trauma assessment and management, neurosurgical spinal emergencies, and neurointensive care, the FY doctors group did not perform better overall than the medical students group in the trauma assessment and management and neurosurgical spinal emergencies pre-lecture quiz (objective knowledge assessment). This could perhaps be explained by the fact that FY doctors felt more confident in assessing and managing patients with head injury and common acute spinal presentations such as cauda equina syndrome having been in clinical practice. The FY doctors did however perform better than their medical student counterparts in the neurointensive care pre-lecture quiz. Early FY doctor work involvement and experience with the critical care outreach team and escalation of patient management may explain the increased confidence and knowledge of FY doctors compared to senior medical students.

In our short focused neurosurgery specific lecture series, apart from the improved confidence levels in assessing and managing patients presenting with neurosurgical complaints, we have demonstrated an objective improvement in participants' knowledge as evidenced by significantly improved SBA questions scores in all our lectures covering common neurosurgical conditions. Teaching programmes such as this are particularly helpful in specialties that junior doctors and medical students have less exposure to. Resnick et al. showed that inclusion of a compact neurosurgery lecture curriculum for medical students resulted in significant improvement in their performance in recognition and management of common neurosurgical disorders [12]. Increased exposures to clinical neurosurgery may significantly improve the ability of future doctors to tackle neurosurgical scenarios [1].

This lecture series was conducted virtually using Zoom. A Pro monthly membership which cost £11.99 (pre-VAT) was purchased to

allow a live streaming (meeting) for up to 100 participants simultaneously with no limit on duration of video. The advantage of Pro over a basic membership was that it allowed unlimited meeting duration instead of a maximum of 40 minutes.

The COVID-19 pandemic has significantly reshaped medical education and established a novel opportunity in the form of virtual learning platforms. We have demonstrated a method of running a virtual teaching programme with this neurosurgery virtual lecture series which was relatively easy to run with very little financial expense and it could be expanded to other surgical specialties that are not well covered in medical schools or taught in postgraduate FY doctors curriculum but have large volume of common presentations to hospital emergency or acute services such as trauma and orthopaedic surgery and ENT surgery. Expanding on that idea, a monthly themed local or regional surgical virtual lecture series would be a very attractive programme.

In terms of limitations, this is a pilot single centre study conducted in one academic year for a combined audience of FY doctors and senior medical students hence the lecture series was limited with participant number and the results may not be generalisable to the wider UK junior doctor and medical student cohorts. Although there was a high response rate, not every FY doctors and students in our hospital have chosen to participate in this lecture series hence we cannot exclude a selection bias of participants influencing results. We sought to minimise this by making the registration as straightforward as possible and open to all medical students and FY doctors in our centre with a lot of effort spent in advertising this programme widely. Future similar virtual lecture series could be run by a regional neurosurgical centre and cater for an audience of all the junior doctors in all different hospitals in the region and also medical students in the regional medical school(s) to further expand the coverage of such a programme.

Finally, with any new teaching initiative whether virtual or not, technical issues can be expected and specifically in the case of online video conferencing tool, technological difficulties especially in areas with poor Wi-Fi or countries with less internet infrastructure could affect the learning experience. That said, the primary challenge of this novel educational tool resides in the community's willingness to embrace the technology.

5. Conclusion

This study has shown that this neurosurgery virtual lecture series that was focused and low-cost was well received and has had a positive impact in knowledge and improved confidence of junior doctors and medical students in assessing and managing patients presenting with neurosurgical conditions. Future expansion of this neurosurgery lecture series into regional or national initiative can further increase exposure to neurosurgery in junior doctors and medical students with the overall aim of improving the care of neurosurgical patients.

Ethical approval

Not required.

Appendix 1. Summary of free-text feedback and suggestions

Positive feedback	Suggestions for improvement
<ul style="list-style-type: none"> ● The lecture gave a good overview of the potential areas for a lesion and expanded my knowledge with new conditions I hadn't heard of ● Interactive nature was very helpful and engages all the participants to get involved ● Case studies of the different types of cranial bleeds - causes, symptoms and signs and the associated CT images ● Very applicable to our level and daily practice, very clear explanation of different spinal emergencies ● Really focused content covering aspects of care most useful to target audience of junior doctors, engaging and very clearly explained. Excellent use of questions to reinforce learning and plenty of opportunities to ask questions along the way 	<ul style="list-style-type: none"> ● Maybe some pre-reading links before the lecture would be good ● Maybe post COVID can run alongside some simulation ● More lectures on other tertiary centre specialties would be great

Data statement

The database used and/or analysed during the current study are not publicly available, but can be available from the corresponding author on reasonable request.

Funding

None.

Author contribution

Jing Xian Lee: Study design, data collection, data analysis, abstract and manuscript preparation, **Ish Ahmed:** Study design, project supervision, review of results and manuscript preparation. All authors approved the final version submitted.

Consent

Participants were informed and consented for the data collected in the pre- and post-lecture questionnaires to be anonymised and analysed for research and publication in scientific journals.

Research registration unique identifying number

Name of the registry: Not applicable

Unique Identifying number or registration ID: Not applicable

Hyperlink to your specific registration (must be publicly accessible and will be checked): Not applicable

Provenance and peer review

Not commissioned, externally peer reviewed.

Guarantor

Jing Xian Lee.

Declaration of competing interest

None.

Acknowledgments

I would like to thank Mr Saffwan Mohamed, Dr Sharmaine Quake, Dr Mat Elameer and Dr Henry Cheng for their help in delivering some of the virtual lectures.

References

- [1] Y. Skarparis, C.A. Findlay, A.K. Demetriades, The teaching of neurosurgery in UK medical schools: a message from British medical students, *Acta Neurochir.* 158 (1) (2016) 27–34, <https://doi.org/10.1007/s00701-015-2651-x>.
- [2] K.J. Whitehouse, A.J. Moore, Undergraduate teaching of neurosurgery - what is the current practice in the UK and is there a need for improvement? *Br. J. Neurosurg.* 29 (6) (2015) 753–757, <https://doi.org/10.3109/02688697.2015.1054361>.
- [3] J. Horan, S. Murphy, D. O'Brien, Neurosurgical education in Ireland; a conference and medical student experiences, *Surgeon* 18 (3) (2020) 159–164, <https://doi.org/10.1016/j.surge.2019.09.003>.
- [4] D.K. Resnick, Neuroscience education of undergraduate medical students. Part I: role of neurosurgeons as educators, *J. Neurosurg.* 92 (4) (2000) 637–641, <https://doi.org/10.3171/jns.2000.92.4.0637>.
- [5] F. Schon, P. Hart, C. Fernandez, Is clinical neurology really so difficult? *J. Neurol. Neurosurg. Psychiatry* 72 (2002) 557–559, <https://doi.org/10.1136/jnnp.72.5.557>.
- [6] A.V. Zinchuk, E.P. Flanagan, N.J. Tubridy, W.A. Miller, L.D. McCullough, Attitudes of US medical trainees towards neurology education: 'neurophobia' – a global issue, *BMC Med. Educ.* 10 (2010) 49, <https://doi.org/10.1186/1472-6920-10-49>.
- [7] A.A. Samaraee, The impact of the COVID-19 pandemic on medical education, *Br. J. Hosp. Med.* 81 (7) (2020) 1–4, <https://doi.org/10.12968/hmed.2020.0191>.
- [8] S.W. Guadix, G.M. Winston, J.K. Chae, A. Haghdel, J. Chen, I. Younus, R. Radwanski, J.P. Greenfield, S.C. Pannullo, Medical student concerns relating to neurosurgery education during COVID-19, *World Neurosurg.* 139 (2020) 836–847, <https://doi.org/10.1016/j.wneu.2020.05.090>.
- [9] Z.I. Almarzooq, M. Lopes, A. Kochar, Virtual learning during the COVID-19 pandemic: a disruptive technology in graduate medical education, *J. Am. Coll. Cardiol.* 75 (20) (2020) 2635–2638, <https://doi.org/10.1016/j.jacc.2020.04.015>.
- [10] W.J. Kemp 3rd, P.F. Recinos, E.C. Benzel, R.P. Schlenk, Silver lining during COVID-19: transformation in neurosurgery education, *World Neurosurg.* 139 (2020) 632–633, <https://doi.org/10.1016/j.wneu.2020.05.148>.
- [11] National Institute for Health and Care Excellence, Head injury: triage, assessment, investigation and early management of head injury in children, young people and adults. <https://www.nice.org.uk/guidance/cg176/resources/head-injury-assessment-and-early-management-pdf-35109755595493>, 2014. (Accessed 29 April 2021).
- [12] D.K. Resnick, L.F. Ramirez, Neuroscience education of undergraduate medical students. Part II: outcome improvement, *J. Neurosurg.* 92 (2000) 642–645, <https://doi.org/10.3171/jns.2000.92.4.0642>.