



Increasing motivation and engagement in neurosurgery for medical students through practical simulation-based learning



John Hanrahan^{a,*}, Michail Sideris^b, Parmenion P. Tsitsopoulos^c, Alexios Bimpis^d, Terouz Pasha^a, Peter C. Whitfield^{e,1}, Apostolos E. Papalois^{f,1,2}

^a Faculty of Life Sciences and Medicine, King's College London, Great Maze Pond, London, SE1 9RT, United Kingdom

^b Women's Health Research Unit, Queen Mary University of London, United Kingdom, Mile End Rd, London, E1 4NS, United Kingdom

^c Section of Neurosurgery, Department of Neuroscience, Uppsala University, Sweden, 751 05, Uppsala, Sweden

^d Department of Neurosurgery, General Hospital of Tripoli, Greece, Erythrou Stavrou Odos, Tripoli, 22100, Greece

^e Southwest Neurosurgical Centre, Plymouth Hospitals NHS Trust, Plymouth, PL6 8DH, UK

^f Experimental Research Centre ELPEN, Athens, Greece

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ABSTRACT

Background: Simulation-based learning (SBL) is an essential adjunct to modern surgical education. Our study aimed to evaluate the educational benefit and motivational impact of a pilot practical neurosurgical module.

Materials and methods: 38 clinical medical students from several EU Medical Schools attended an international surgical course focused on teaching and learning basic surgical skills. We designed a pilot neurosurgical workshop instructing students to insert an intracranial pressure bolt using an ex vivo pig model. Each delegate was assessed by two consultant neurosurgeons using a validated assessment tool. Structured questionnaires were distributed on completion of the module.

Results: Delegate performance increased ($p < 0.001$) with no difference in performance improvement across year of study ($p = 0.676$) or medical school ($p = 0.647$). All delegates perceived this workshop as a potential addition to their education (median 5/5, IQR = 0), and indicated that the course provided motivational value towards a neurosurgical career (median 4/5, IQR = 1), with no difference seen between year of study or medical school ($p > 0.05$).

Conclusion: Our pilot neurosurgical workshop demonstrated the educational value of practical SBL learning for motivating students towards a surgical career. Homogeneous views across year of study and medical school underline the value of developing a unified strategy to develop and standardise undergraduate surgical teaching with a practical focus.

1. Introduction

Undergraduate simulation-based learning (SBL) aims to facilitate learning in a safe environment, whilst providing useful and realistic educational experiences [1]. The UK surgical training model is in transition from an apprenticeship style towards a competency-based model [1]. Therefore, integration of realistic surgical simulation into undergraduate curricula may aid the preparation of prospective surgeons to meet the demands of steep learning curves in both technically complex procedures and meeting the demands of advancing technology.

At present, neurosurgical training faces several challenges. Increasing emphasis on general practice principles during medical school has meant student exposure to surgical specialities is becoming more limited [2,3]. A survey of final year medical students in the UK showed one third were unable to identify the need for a neurosurgical referral [4], and calls have been made for national guidelines for undergraduate neurosurgical teaching to be established [3]. This is compounded with a reported decrease in applications to neurosurgical training programmes [5], perhaps attributed to perceived high workload, risk of burnout [6] and susceptibility to litigation [7]. It has also been shown that medical students refrain from undertaking a

* Corresponding author.

E-mail addresses: John.hanrahan@kcl.ac.uk (J. Hanrahan), m.sideris@qmul.ac.uk (M. Sideris), par_tsits@yahoo.gr (P.P. Tsitsopoulos), alexios_bibis@yahoo.com (A. Bimpis), terouz.pasha@kcl.ac.uk (T. Pasha), peter.whitfield@nhs.net (P.C. Whitfield), apapalois@elpen.gr (A.E. Papalois).

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neurosurgical career due to the earlier clinical experiences they have had with other surgical specialities [5]. Hence, undergraduate neurosurgical experience may motivate students to pursue a career in neurosurgery.

Essential Skills in the Management of Surgical Cases (ESMSC) [8] is an international undergraduate surgical course accredited by the European Accreditation Council for Continuous Medical Education (EACCME). Students from several medical schools across the European Union undertake a series of dry lab, ex vivo and high fidelity in vivo simulation modules. We aimed to identify whether a pilot ex vivo neurosurgical simulation module, within the setting of an undergraduate surgical course teaching, could improve the performance of delegates with no previous practical neurosurgical experience. We also sought to quantify the motivational impact of the workshop towards a neurosurgical career.

2. Methods

2.1. ESMSC course

ESMSC is a biannual, three-day international undergraduate surgical course. The current ESMSC curriculum (Core Integrated for Research–Ci4R) combines 42 stations of *high* and *low* fidelity ex vivo, in vivo and dry lab simulation with small group workshops. The detailed structure of ESMSC has been described previously [8], which provides a framework teaching practical surgical skills, theoretical knowledge, non-technical skills and case-based discussion [9]. Parallel to the course, academic projects are conducted by the medical education research group (eMERG) [10].

38 clinical medical students (year 3–6) from several European (EU) countries were selected to participate following blind assessment of their online application against curriculum vitae (CV) criteria. The scoring system is standardised and focused to deliver a homogenous sample of participants with equal pre-course experience.

Faculty is selected to meet the course needs, and instructors are invited following nomination by the course committee. The faculty comprises instructors from various EU countries at different training stages, ranging from core surgical trainees to certified, consultant level specialists.

Ethical approval was obtained as per European and National Legislation (Directive 63/2010, PD 56/April 2013, reference number 884 28/4/2015, MS, AP et al.).

2.2. Neurosurgical module

As part of the course, we prospectively designed and evaluated a cluster of neurosurgical teaching modules, one of which has been reported previously [11]. The UK neurosurgical training syllabus incorporates insertion of intracranial pressure (ICP) as a core competency; this procedure was chosen to be the focus of a pilot simulation model. All students were confirmed to be naïve to the procedure.

The pig heads were prepared according to the local standard operational procedures (SOP), with dissection of the skin and overlying fascia to expose the skull (Fig. 1). A Codman hand drill, ICP transducer and monitor were used.

The preparatory lecture included a demonstration of the procedure by the faculty focusing on the indications, technical details and pitfalls to avoid during the procedure. Precise instruction on positioning of the twist drill hole, handling of the instruments and correct insertion of the probe were also included (Fig. 2). Additionally, the Monro-Kellie doctrine physiology was described.

2.3. Procedure assessment

Each student performed the procedure once. Two consultant neurosurgeons assessed the delegates after each step of the module using a

validated tool - Direct Observation of Procedural Skills (DOPS) tool, scored as follows: 0 (Not observed), 1 (Development required) to 2 (No prompting or intervention required) [12–16]. Global performance was assessed on a scale of 0–4 as follows: 0 - Insufficient evidence observed to support a judgement, 1 - unable to perform procedure under supervision, 2 - able to perform procedure under supervision, 3 - able to perform procedure with minimal supervision and 4 - competent to perform the procedure unsupervised. Domains assessed included handling of instruments, quality of burr hole performance, intracranial pressure (ICP) catheter insertion, confidence, dexterity and global performance.

2.4. Student questionnaire

An anonymous, structured feedback questionnaire was distributed on completion of the module using a Likert scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree). The feedback questionnaire focused on three core domains: module content, prior exposure to neurosurgery and the impact of the module on student perceptions of neurosurgery.

2.5. Statistical analysis

Non-parametric univariate descriptive statistical analysis was performed to primarily describe cohort data using SPSS version 22 for MAC (IBM Corp., Armonk, USA) software. Performance improvement was measured using Wilcoxon test. Comparisons across different groups based on year of studies or Medical School, were performed with Kruskal Wallis test. P value of less than 0.05 was considered as statistically significant.

3. Results

3.1. Demographics

20 (53%) students came from Greek universities, whilst 9 (23.7%) were from European University of Cyprus, 4 (10.5%) from Eastern Europe and 5 (13.2%) from King's College London. 7 (18.4%) students were in their first year of clinical medicine, 14 (36.8%) students in their second, 10 (26.3%) students in their third and 7 (18.4%) students in their fourth.

3.2. DOPS

Table 1 reports the improvement in observed global performance across different Medical Schools and Year of Studies (scale used 0–4). Kruskal-Wallis test comparison of global performance across different medical schools ($p = 0.647$) or year of studies ($p = 0.676$), revealed no statistically significant difference.

All delegates improved their median global score outcome by 2.00 out of 4.00 (IQR = 1, $p < 0.001$) as well as their performance in each part of the module in a statistically significant manner ($p < 0.001$ for all Wilcoxon test associations).

3.3. Questionnaire feedback

Responses from the questionnaire distributed after the module are summarised in Table 2. Students concluded that the workshop increased their motivation towards neurosurgery (median = 4.00/5.00, IQR = 1) or surgery in general as a career (median = 4.00/5.00, IQR = 1). Students stated ex vivo workshops should be integrated as part of the medical school curriculum (median 5.00/5.00, IQR = 0). There was no statistically significant difference in any of the responses when comparing students' views across different medical schools or year of studies ($p < 0.05$ for all associations).



Fig. 1. Ex vivo pig heads used in workshop.

4. Discussion

Surgical specialities such as neurosurgery face challenges in the recruitment of trainees. High competition ratios exceeding 10:1 have reduced to around 4:1 over the past decade within neurosurgery in the UK (Personal communication, PC Whitfield). In addition, limited exposure to neurosurgery in the undergraduate curriculum restricts medical student insight into the speciality [2,3]. Developing high quality educational experiences to promote undergraduate neurosurgical education is one method of countering such challenges. Several resources support elective programmes [2], hospital rotations [17] and student selected components [18] as ways to alter negative perceptions and increase interest towards the speciality. We describe the impact of a practical, ex vivo neurosurgical simulation.

4.1. Module performance

Our results show that delegates improved their performance in inserting an intracranial pressure monitor into a pig model (Table 1). Although students were not assessed performing the procedure prior to the module, all of them were verbally confirmed to be naïve to the procedure. We acknowledge this limitation of our study, however, as ICP bolt insertion is a skill not included in current undergraduate medical school curricula, this inference is justified as a comparison for baseline performance.

All students demonstrated the ability to perform several neurosurgical skills in a simulated setting. Whilst the effect of the skills developed in our neurosurgical module on future clinical practice has not been assessed, early development of surgical skills in medical school has been shown to improve student confidence, interest and provide foundations to build on in postgraduate surgical careers [19]. This is



Fig. 2. Demonstration of neurosurgical procedure, with Codman hand drill used to create burr hole.

Table 1
Global performance improvement across year-of studies and medical school.

Year of study	Medical school	Percentiles	Global performance improvement	
Year 3	Eastern Europe Medical Schools	Median	3.00	
		25	3.00	
		50	3.00	
		75	3.00	
	UK Medical Schools	Median	2.00	
		25	2.00	
		50	2.00	
Year 4	Greek Medical Schools	Median	3.00	
		25	2.00	
		50	3.00	
		75	.	
	European University of Cyprus	Median	2.00	
		25	1.50	
		50	2.00	
		75	3.00	
	Eastern Europe	Median	2.50	
		25	2.00	
		50	2.50	
		75	.	
	Year 5	Greek Medical Schools	Median	2.50
			25	2.00
50			2.50	
75			3.25	
Year 6	Greek Medical Schools	Median	2.00	
		25	2.00	
		50	2.00	
		75	3.00	

Scale used: 0–4: 0 - Insufficient evidence observed to support a judgement, 1 - unable to perform procedure under supervision, 2 - able to perform procedure under supervision, 3 - able to perform procedure with minimal supervision and 4 - competent to perform the procedure unsupervised.

Table 2
Responses from feedback questionnaire (Scale used 0–5).

Question	Median	Percentiles		
		25	50	75
The content was delivered at an appropriate level	5.00	4.00	5.00	5.00
The content was relevant to my training	4.00	4.00	4.00	5.00
I have considered neurosurgery as a career before this workshop.	3.00	1.00	3.00	5.00
I have experienced neurosurgical teaching before this conference.	1.00	1.00	1.00	2.00
I have experienced ex vivo surgical workshops before this conference.	2.00	1.00	2.00	4.00
This workshop has increased my interest in surgery	4.00	4.00	4.00	5.00
This workshop has increased my interest in neurosurgery	4.00	3.00	4.00	4.00
This workshop motivates me to pursue a career in surgery	4.00	3.00	4.00	5.00
This workshop motivates me to pursue a career in neurosurgery	5.00	3.00	5.00	5.00
I would recommend this workshop to a colleague	5.00	4.00	5.00	5.00
Ex Vivo workshops are an important tool for medical education	5.00	5.00	5.00	5.00
Medical schools should provide ex vivo workshops for surgical training.	5.00	5.00	5.00	5.00
Overall, this teaching session was of a high quality	5.00	4.00	5.00	5.00
Motivation after module	4.00	3.00	4.00	4.00

supported by the delegate feedback, where students perceived the workshop to be of high quality, relevant to their training and motivating for both careers in neurosurgery and surgery in general (Table 2).

No difference was noted in any performance outcome across different years of study (Table 1, $p > 0.05$ for any association). Whilst our small sample size may limit the power of our analysis, previous

experiences with the course [8,20], alongside other studies [21] support this finding. We feel this may represent a lack of exposure to practical surgical teaching in undergraduate surgical education which should be addressed further in larger scale prospective studies. In addition, delegates predominantly confirmed very little or no neurosurgical teaching prior to the course (Table 2). In line with Whitehouse et al. [3], we feel this finding supports the need for increased involvement of neurosurgeons in undergraduate curriculum design. We recognise that the course delegates represent those already motivated in pursuing extracurricular surgical experiences, which may mean the experience reported may overrepresent the neurosurgical experience of the average medical school population. Additionally, a small proportion of students were in their first year of clinical medicine, and may not have experienced neurosurgery yet as part of their medical school curriculum. Similarly, there was no obvious difference in students' views on this pilot module across different medical schools (Table 1, $p > 0.05$ for any association). This reflects a potential need to revisit modern medical schools' curricula to support SBL integration at the earliest possible stage [22]. Developing motivational initiatives with international character is vital to maintain a high competitive pool of future applicants, resulting in a well skilled future generation of neurosurgeons.

4.2. Students' overall feedback

Students rated the module as high quality and found the module relevant to their training (Table 2). Additionally, it had a positive impact on student's interest and motivation towards neurosurgery (Table 2). Similar findings have been found with clinical neurosurgery teaching in the UK [23], supporting the value of undergraduate initiatives. Such exposure can aid career planning and preparation to satisfy the demands of a neurosurgical career [24]. Our experience, alongside other cited initiatives represent avenues to promote the speciality at an undergraduate level. Additionally, our findings support the use of ex vivo workshops as a realistic and safe educational tool for students to immerse themselves in a simulated surgical environment, familiarising themselves with the use of equipment and procedures whilst experiencing practical aspects of a surgical speciality.

5. Conclusion

Neurosurgical SBL workshops can improve students' motivation to pursue a relevant career. Lack of exposure to neurosurgery and practical skills reported in our study may reflect a need for reform of undergraduate curricula to engage students in the speciality and to supplement clinical knowledge with appropriate practical skills. Homogenous views reported across varying multinational educational background underlines similar educational needs. This could be further facilitated by enhancement of international initiatives, either as part of elective or internship placements, or equally with similar courses, to provide a forum to share ideas in an international educational setting. Whilst these conclusions are limited by the small sample size of the study, they create important questions to be answered by further studies.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethics

European and National Legislation, Directive 63/2010, PD 56/April 2013, License Number: revised 884 28/4/2015 (MS/AP).

Manual of the course

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Conflicts of interest

Not Applicable.

Consent

NA.

Author contribution

JH has drafted the manuscript. MS edited part of the manuscript and had lead role in the ESMSC course. MS and AP are the ESMSC leads and conceived the idea of ESMSC. TP, PT, AB have contributed in drafting and editing the manuscript. AP and PW are the senior author of the study.

Registration of research studies

NA.

Guarantor

Michail Sideris and John Hanrahan are guarantors of this work.

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