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Review Article

COVID-19 impact on the global neurosurgery resident training course and admission: A scoping review

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ABSTRACT

Background: This study looks at how COVID-19 affected the admission and training of neurosurgical residents worldwide.

Methods: From 2019 to 2021, we reviewed multiple databases (i.e., Google Scholar, Science Direct, PubMed, and Hinari) to evaluate the impact of the COVID-19 pandemic on neurosurgery resident training and admission in low middle-income countries (LMICs) and high-income countries (HICs). We then utilized a Wilcoxon signed-rank test to evaluate the difference between the two LMIC/HICs and employed Levene's test to assess the homogeneity of variances.

Results: There were 58 studies that met our inclusion criteria; 48 (72.4%) were conducted in HIC and 16 (27.6%) in LMIC. The admission of new residents was mostly canceled in HIC (31.7%; n = 13) and in LMIC (25%; n = 4) from 2019 to 2021 due to COVID-19. Learning modalities changed to include predominantly video conferencing (i.e., 94.7% [n = 54] of cases). Further, neurosurgery was largely restricted to emergency cases alone (79.6% [n = 39]), with only 12.2% (n = 6) elective cases. The result was a marked reduction in resident surgical training (i.e., 66.7% [n = 10] in LMIC and 62.9% [n = 22] in HIC), despite increased workloads in (i.e., LMIC [37.4%; n = 6] and HIC [35.7%; n = 15]). This was attributed to the marked reduction in the number of surgical patients allotted to each resident (i.e., LMIC [87.5%; n = 14] than HIC [83.3%; n = 35]).

Conclusion: The COVID-19 pandemic markedly disrupted neurosurgical education globally. Although differences have been found between LMICs and HICs training, the reduction of neurosurgical case-loads and surgical procedures has significantly impacted neurosurgical training. The question remains, how can this "loss of experience" be redressed in the future?

Keywords: High-income countries (HICs), Impact of COVID-19, Low middle-income countries (LMICs), Neurosurgery, Residency training

INTRODUCTION

Many studies have focused on COVID-19-related delays and even global cancellations of neurosurgery residency training programs in low middle-income countries (LMICs)

and high-income countries (HICs). Even with fewer working hours, neurosurgery residents showed a 26.1% burnout, and reduced 73.9% career satisfaction rate.[5] Despite 76% of neurosurgery residents actively managing COVID-19 patients, with some developing significant respiratory infections themselves, only 57% felt that they were adequately supervised during medical and/or surgical treatment (i.e., emergent, few elective procedures) of COVID-19 patients.[8]

Further, there have been significant reductions in conventional training opportunities (i.e., cancellation of educational/multidisciplinary subspecialty meetings, and outpatient clinics) in LMIC versus HIC.

METHODS IN INCLUDING PATIENT SELECTION

We reviewed how the COVID-19 pandemic impacted the admission and training of neurosurgical residents worldwide, that is, including assessment from the EQUATOR Network.[12] The research was carried out using several databases; Google Scholar, PubMed, ScienceDirect, Web Of Science, and Scopus, from December 2019 to August 2021 using the following queries; "impact of COVID-19," "resident training, neurosurgery," "admission," "surgical practice," "LMIC and HIC." Multiple authors independently screened the titles and abstracts of identified articles, utilizing the previously agreed on inclusion and exclusion criteria; full texts of the remaining articles were also independently retrieved/screened by ten reviewers. Inclusion criteria included; assessment of admission criteria for new neurosurgery residents, use of videoconferencing, training for and/or redeployment of residents to other services for managing COVID-19, the number/type of neurosurgical operations performed, and the frequency of residents developing COVID-19 themselves.

Data analysis

Data analysis was conducted with JAMOVI 2.3.18 for statistical analysis of univariable (i.e., frequencies and percentages for qualitative variables, 95% confidence intervals [95% CI] for quantitative variables) and bivariable (i.e., odds ratios and their 95% CI, Chi-square test, and ANOVA), and multinomial regression analyses. Interregional and intraregional comparisons were made using bivariate correlations for the World Bank Country by Income (LMICs and HICs). A Wilcoxon signed-rank test was used to evaluate whether there was a significant difference between them (i.e., $P < 0.05$). Levene's test (Independent samples *t*-test) was used to evaluate the assumption of homogeneity of variances (i.e., low *P*-value indicated violation of the assumption of equal variances).

RESULTS

58 Articles from four continents

We ultimately used 58 articles for data extraction (i.e., just 4.75 % of those originally identified, published between January 2020 and August 2021). Half were from the USA (n = 29, 50%), fifteen (25.86%) from Asian countries, six (10.34%) from Europe, and two from Africa (3.44%) [Table 1].

Data for HIC versus LMIC neurosurgical residency admissions and training

Seventy-two-point four percentages (n = 42) of the included studies were conducted in HIC and 27.6% (n = 16) in LMIC. The admission for neurosurgery residency was canceled in 13 centers of HIC (31.7%) versus four centers (25%) in LMIC. The COVID-19 impact worldwide; admission rates for neurosurgery residents were maintained at 49.1% (n = 28; without delays), but was canceled in 29.8% (n = 17) of cases. Learning was converted 94.7% (n = 54) of the time to videoconference with 51.7% (n = 30) of satisfaction (i.e., benefice vs. face-to-face learning). Notably, 71.7% (n = 33) reported neurosurgery residents' redeployment to other departments for the management of COVID-19 patients, with a workload increased by 37.9% (n = 22) [Table 2]. Nevertheless, these residents demonstrated a low 41.8% (n = 23); in HIC versus 43.8% (n = 7) in LMIC level of knowledge COVID-19, that spread to 95.2% (n = 20) of involved residents (i.e., most deployed for COVID-19 service in LMIC at 84.6% [n = 11] versus 66.7% [n = 22] in HIC). Further, neurosurgery surgical procedures, largely restricted to emergency cases only (i.e., 79.6% [n = 39]) versus just 12.2 % (n = 6) for elective surgery, resulted in a reduction of neurosurgery residency experience by 64% (n = 32), with the number of patients operated on per resident was reduced

Table 1: Number of studies per country.

Country	Study per country
United States of America	29
United Kingdom	3
Canada	4
Italy	3
Morocco	1
DRC	1
India	6
Brazil	1
Kuwait	1
Iran	2
Thailand	1
Mexico	1
Iraq	2
Pakistan	1
Saudi Arabia	2

Table 2: Global summary of COVID-19 impact on neurosurgery residency training.

Variable	*n* (%)	Mean±StD	95% CI of the mean
			Lower upper
Admission in neurosurgery		1.81±0.87	1.57 2.04
Maintained without delay	28 (49.1)		
Maintained with delay	12 (21.1)		
Canceled	17 (29.8)		
Videoconference learning		1.05±0.22	0.93 1.11
Yes	54 (94.7)		
No	3 (5.3)		
Video/face-to-face learning[a]		1.90±0.96	1.64 2.15
Beneficial	30 (51.7)		
Not beneficial	4 (6.9)		
Unspecified	24 (41.4)		
Redeployment of residents[b]		1.28±0.45	1.15 1.42
Yes	33 (71.7)		
No	13 (28.3)		
Information[c]		1.80±0.77	1.59 2.01
Low	23 (41.8)		
Good	20 (36.4)		
Very good	12 (21.8)		
Training[d]	38 (80.9)	1.19±0.39	1.07 1.31
Yes	9 (19.1)		
No			
Contamination[e]		1.14±0.48	1.50 1.78
Yes	20 (95.2)		
No	1 (4.8)		
Resident workload		2±0.79	1.79 2.21
Reduced	18 (31)		
Increased	22 (37.9)		
Unchanged	18 (31)		
Surgery[f]		1.29±0.70	1.11 1.48
Reduced	49 (84.5)		
Increased	1 (1.7)		
Unchanged	8 (13.8)		
Type of surgery performed		1.29±0.61	1.11 1.46
Emergency	39 (79.6)		
Elective	6 (12.2)		
Both	4 (8.2)		
Acquisition surgical practice	18 (36)	1.64±0.48	1.50 1.78
Improved	32 (64)		
Lost			

n: Frequency, %: Percentage, StD: Standard deviation, 95% CI: 95% of confidence interval. [a]Video conference Learning compare to face-to-face learning, [b]Redeployment of Residents to other services for the management of COVID-19, [c]Resident's level of information on COVID-19, [d]Training Resident for managing COVID-19, [e]Resident contaminated with COVID-19, [f]Number of patients operated on per Resident

by 84.5 % (*n* = 49: lost in LMIC [66.7%; *n* = 10] than in HIC [62.9%; *n* = 22]) [Table 3].

DISCUSSION

Reductions in neurosurgical admissions, training, and surgical experience

We identified that from the 58 studies on the impact COVID-19 had on neurosurgery resident training and admission was maintained in the vast majority of cases 70.2% [*n* = 40]) around the world. Fourty two of the studies were from HIC (72.4%) and 16 (27.6%) were conducted in LMIC. Worldwide, the admissions for neurosurgery residencies were maintained without delay in almost half of the cases 49.1% (*n* = 28), while they were delayed in 21.1% (*n* = 12), and canceled only in 29.8% (*n* = 17) of cases. Nonetheless COVID-19 reduced technical neurosurgical experience by 64%, dealing mainly with emergency cases (79.6%) with very little elective

Table 3: Summary of COVID-19 impact on neurosurgery residency in LMIC versus HIC.

Variable	*n* (%)		Mean±StD		*P*-value
	LMIC	HIC	LMIC	HIC	
World bank country by income	16 (27.6)	42 (72.4)			
Admission in neurosurgery	16 (28.1)	41 (71.9)	1.69±0.87	1.85±0.88	0.086
Maintained without delay	9 (56.3)	19 (46.3)			
Maintained with delay	3 (18.8)	9 (22)			
Canceled	4 (25)	13 (31.7)			
Videoconference learning	15 (26.3)	42 (73.7)	1.00±0.00	1.07±0.26	0.026
Yes	15 (100)	39 (92.9)			
No	00	3 (7.1)			
Video/face-to-face learning[a]	16 (27.6)	42 (72.4)	2.00±1.03	1.86±0.95	0.015
Beneficial	8 (50)	22 (52.4)			
Not beneficial	00	4 (9.5)			
Unspecified	8 (50)	16 (38.1)			
Redeployment of Residents[b]	13 (28.3)	33 (71.7)	1.15±0.37	1.33±0.47	0.005
Yes	11 (84.6)	22 (66.7)			
No	2 (15.4)	11 (33.3)			
Information[c]	16 (29.1)	39 (70.9)	1.69±0.70	1.85±0.81	0.423
Low	7 (43.8)	16 (41)			
Good	7 (43.8)	13 (33.3)			
Very good	2 (15.5)	10 (25.6)			
Training[d]	14 (29.8)	33 (70.2)	1.07±0.26	1.24±0.43	0.002
Yes	13 (92.9)	25 (75.8)			
No	1 (7.1)	8 (24.2)			
Contamination[e]	5 (23.8)	16 (76.2)	1.05±0.17	1.23±0.27	0.567
Yes	5 (100)	15 (93.8)			
No	00	1 (6.3)			
Resident workload	16 (27.6)	42 (72.4)	1.94±0.77	2.02±0.81	0.064
Reduced	5 (31.3)	13 (31)			
Increased	6 (37.4)	15 (35.7)			
Unchanged	5 (31.3)	14 (33.3)			
Surgery[f]	16 (27.6)	42 (72.4)	1.19±0.54	1.33±0.75	0.011
Reduced	14 (87.5)	35 (83.3)			
Increased	1 (6.3)	00			
Unchanged	1 (6.3)	7 (16.7)			
Type of surgery performed	15 (30.6)	34 (69.4)	1.40±0.73	1.24±0.55	<0.001
Emergency	11 (73.3)	28 (82.4)			
Elective	2 (13.3)	4 (11.8)			
Both	2 (13.3)	2 (5.9)			
Acquisition surgical practice	15 (30)	35 (70)	1.67±0.48	1.63±0.49	0.078
Improved	5 (33.3)	13 (37.1)			
Lost	10 (66.7)	22 (62.9)			

n: frequency, %: percentage, StD: Standard deviation, 95% CI: 95% of confidence interval, LMIC: Low middle-income countries, HIC: High-income countries. [a]Video conference Learning compare to face-to-face learning, [b]Redeployment of Residents to other services for the management of COVID-19, [c]Resident's level of information on COVID-19, [d]Training resident for managing COVID-19, [e]Resident contaminated with COVID-19, [f]Number of patients operated on per resident

surgery 12.2%. Moreover, the number of patients operated on per resident was reportedly reduced by 84.5%.

Implications

Saad *et al.*[10] reported an 80% reduction in neurosurgical case volume and a 66% decrease in hospital revenue from neurosurgery in 2020. Junior neurosurgical residents experienced a significant reduction in neurosurgical admissions (47%; $P < 0.01$) and bedside procedures (59%; $P < 0.01$) Notably, COVID-19 negative impacted surgical case volume for all programs. Specifically, for Aljuboori *et al.*[2,3] (2019-2020) observed, their mean case volumes declined by 15% (March 2019) and 49% (April 2020), respectively.[6,7,11,13]

Further, 75% of reported didactics were negatively affected, although we found that videoconferences proved beneficial 93.1% (n = 54) of the time.

Redistribution of hospital resources

This redistribution of hospital resources to combat COVID-19 depleted the neurosurgical staff due to interim deployment to other services/functions and training. Fortunately, many training centers utilizing virtual meetings to discuss weekly case rounds and allow for didactic presentations.

Keeping neurosurgery residents safe from COVID-19 by developing two teams: Inpatient versus remote

Neurosurgery residents and fellows during the pandemic were utilized as front-line providers in Academic Medical Centers. Nevertheless, to keep them "safe," we found some institutions adopted a two-team approach: "active-duty inpatient" and "remotely working." These two teams remained completely isolated from each other to decrease the exposure to the virus. They worked in 2-week cycles, allowing the team-work from active duty to self-isolate, while the others looked out for the onset of symptoms in the hospital setting (i.e., during the potential incubation periods). This two-team method appeared to reduce the chance of transmitting the infection to other team members or patients.[1,4,9]

COVID-19 harm to neurosurgery training

COVID-19 harmed neurosurgical training; 64% reported the loss of resident experience, coupled with the reduction of exposure to surgery (84.5%), and exposure to mainly emergency (79.6%) versus elective cases.

CONCLUSION

Neurosurgery residents around the world have faced serious and ongoing challenges due to the COVID-19 pandemic. It disrupted the training, and specifically, hands-on surgical experience. Strategies to minimize the disruption of neurosurgical education in low and HICs should be developed to tackle future similar events.

Declaration of patient consent

Patients' consent not required as patients' identities were not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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