

COVID-19 Exposure During Neurology Practice

Results of American Academy of Neurology Survey

Adnan I. Qureshi, MD,* Carol Rheaume, MSPH,† Wei Huang, MA,*
Iryna Lobanova, MD, PhD,* Raghav Govindarajan, MD,*
Brandi R. French, MD,* Farhan Siddiq, MD,‡ Camilo R. Gomez, MD,*
and Pradeep K. Sahota, MD*

Background: To determine the exposure risk for coronavirus 2019 (COVID-19) during neurology practice. Neurological manifestations of COVID-19 are increasingly being recognized mandating high level of participation by neurologists.

Methods: An American Academy of Neurology survey inquiring about various aspects of COVID-19 exposure was sent to a random sample of 800 active American Academy of Neurology members who work in the United States. Use of second tier protection (1 or more including sterile gloves, surgical gown, protective goggles/face shield but not N95 mask) or maximum protection (N95 mask in addition to second tier protection) during clinical encounter with suspected/confirmed COVID-19 patients was inquired.

Results: Of the 81 respondents, 38% indicated exposure to COVID-19 at work, 1% at home, and none outside of work/home. Of the 28 respondents who did experience at least 1 symptom of COVID-19, tiredness (32%) or diarrhea (8%) were reported. One respondent tested positive out of 12 (17%) of respondents who were tested for COVID-19 within the last 2 weeks. One respondent received health care at an emergency department/urgent care or was hospitalized related to COVID-19. When seeing patients, maximum protection personal protective equipment was used either always or most of the times by 16% of respondents in outpatient setting and 56% of respondents in inpatient settings, respectively.

Conclusions: The data could enhance our knowledge of the factors that contribute to COVID-19 exposure during neurology practice in United States, and inform education and advocacy efforts to neurology providers, trainees, and patients in this unprecedented pandemic.

Key Words: survey, neurology, coronavirus 2019, exposure, neurologists, questionnaire

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By July 15, the Center for Disease Control and Prevention (CDC) reported that the United States had 3.35 million total coronavirus disease 2019 (COVID-19) cases and 135,235 deaths.¹ Approximately 20% of the patients with COVID-19 were health

care workers with most likely exposure occurring at work.² The risk to health care workers had been previously recognized in a Chinese report which identified 3300 health care workers with COVID-19 by early March with 22 resulting deaths.³ The Chinese CDC reported that 1716 (3.8%) of 44,672 laboratory confirmed COVID-19 cases were health care workers.⁴ In Italy, as on March 15, 2020, there were 2026 documented health care workers with COVID-19.⁵ Compared with the general community, health care workers were at increased risk for developing COVID-19 (adjusted hazards ratio 11.61).⁶ Therefore, determining the exposure risk is essential to ensure appropriate preventive strategies for health care workers.³

Neurologists across the world are involved in care of patients with suspected or confirmed COVID-19 but the exposure risk during neurology practice is not understood. The issue has gained more prominence as neurological manifestation of COVID-19 are increasingly being recognized mandating high level of participation by neurologists. Patients with COVID-19 are presenting with headaches, seizures, ischemic stroke, demyelinating neuropathies, encephalitis, and postinfectious cerebral demyelination.^{7–9} The goal of the survey was to study factors related to COVID-19 exposure during neurology practice in United States and assess their use of personal protective equipment (PPE) in a variety of practice settings during 2 weeks in July 2020.

METHODS

In March 2020, Adnan I. Qureshi, MD, of the University of Missouri, submitted a collaborative research proposal to American Academy of Neurology (AAN), including proposed methods and an initial draft of the survey instrument. The Member Research Subcommittee (MRS) approved the proposal conceptually (April 27), the Quality Committee (QC) agreed to sponsor the research project (April 13), and a data use agreement between the AAN and University of Missouri was signed (July 19). The instrument and research methods were reviewed and revised by AAN Insights team and the MRS members. The project was approved by the University of Missouri-Columbia Institutions Review Board (IRB) (FWA Number: 00002876, IRB Registration Numbers: 00000731, 00009014).

Target Population

The AAN has 92.5% of the US market share of neurologists based on both American Medical Association and AAN's 2019 data. The AAN survey team selected a population of active members that fit the project criteria which were: AAN members who work in the United States; were either neurologists, advanced practice providers, interns, fellows, residents, or medical students in their third and fourth year; and were aged 75 years or less. After exclusion of AAN members who had

From the *Zeenat Qureshi Stroke Institute and Department of Neurology; ‡Division of Neurosurgery, University of Missouri, Columbia, MO; and †Insights, American Academy of Neurology, Minneapolis, MN.

The authors declare no conflict of interest.

Correspondence to: Iryna Lobanova, MD, PhD, Department of Neurology, University of Missouri, One Hospital Drive, CE507, Columbia, MO 65212. E-mail: lobanovanmu@gmail.com.

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received an AAN survey in between February and July, were on the AAN or AAN Institute Board of Directors, the QC or the MRS Board of Directors and MRS, the QC, and those who received a survey in last 6 months, a random sample of 800 members was generated. The sample size of 800 has been used by AAN survey team as a standard sample and no member receives more than 1 survey every 6 months to avoid excessive querying of membership. A comparison between demographics of AAN membership and study sample is provided in Table 1. Advanced practice providers, and neurologists with neurocritical care and neuro-ophthalmology were overrepresented and medical students and neurologists missing a primary subspecialty were underrepresented. On July 16, an invitation to participate in the survey was sent by email, signed by Adnan I. Qureshi, MD and Lyell K. Jones, MD, FAAN with 2 reminder emails sent to nonrespondents on July 21 and July 28. Five participants had undeliverable email addresses and were removed from the sample, leaving 795.

Survey Instrument

The demographic data regarding age, sex, race, primary and secondary subspecialty, practice setting, and years since residency and/or fellowship were acquired from the AAN database (Supplemental material, Supplemental Digital Content 1, <http://links.lww.com/NRL/A58>). The survey asked respondents to answer most of the survey questions based on their experiences in the previous 2 weeks. For this survey, the 2-week timeframe occurred in July of 2020 and will be referred to as "July." Also, patients with suspected/confirmed COVID-19 or those not suspected/confirmed COVID-19 will be referred to as COVID-19 patients and non-COVID-19 patients, respectively.

Respondents were inquired regarding new and follow-up patient visits in-person, or by telemedicine and categorized into: 1 to 9, 10 to 29, 30 or more visits. Furthermore, the respondents were inquired regarding how much time, on average, did they spend with the patients during new and follow-up visits. Similar questions were inquired regarding inpatient visits. Respondents were inquired regarding many new and follow-up visits were with patients with suspected/confirmed COVID-19 patients in outpatient and inpatient settings.

Respondents were asked regarding using second tier protection (had 1 or more including sterile gloves, surgical gown, protective goggles/face shield but not N95 mask) or maximum protection (had N95 mask, sterile gloves, surgical gown, protective goggles/face shield) during clinical interaction with suspected/confirmed COVID-19 patients and those who were not suspected/confirmed COVID-19 patients. The use was categorized as always, most of the time, about half of time, some of the time, and never. The respondents were asked regarding performance of invasive procedures categorized as: (1) Aerosol-generating procedures (aerosol-generating procedures include endotracheal intubation, bronchoscopy, open suctioning, administration of nebulized treatment, manual ventilation before intubation, physical proning of the patient, disconnecting the patient from the ventilator, noninvasive positive pressure ventilation, tracheostomy, and cardiopulmonary resuscitation); (2) Needle insertion procedures (needle insertion procedures include electromyography, Botox injection, pain-related injections, epidural injections); (3) Lumbar puncture procedures; (4) Catheter-based procedures in intensive unit (central venous catheter, arterial catheter, pulmonary artery catheter); and (5) Catheter-based procedures in interventional suites (cerebral angiography, endovascular procedures including but not limited to thrombectomy, or carotid stent placement).

Respondents were asked whether they had any of the symptoms of COVID-19 in last 2 weeks including cough, fever,

tiredness, difficulty breathing, or diarrhea. Respondents were asked if they were screened for COVID-19 in last 2 weeks and if screened whether the results were positive, negative, or indeterminate. Respondents were asked if they personally received health care at an emergency department/urgent care/clinic health care or as inpatient and whether the health care was related to COVID-19.

The respondents were asked regarding personal risk status to understand vulnerability to COVID-19. They were asked regarding cigarette smoking status categorized as: none; 1 to 3 per day; 4 to 9 per day; 10+ per day; or unknown, and body mass index (kg/m²) was categorized as: under 18.5; 18.5 to 24.9; 25 to 29.9; 30 to 34.9; 35 to 39.9; and 40 and over. Respondents were asked regarding history of chronic lung disease (asthma, chronic obstructive pulmonary disease, pulmonary fibrosis), heart disease (coronary artery disease, congestive heart failure, heart rhythm problems), stroke, cancer, diabetes mellitus, or hypertension and if they were using medication for the above-mentioned conditions. The respondents were asked how much stress they had in the last 2 weeks, specifically how much stress have you felt with your work/job, categorized as: a great deal, a lot, a moderate amount, a little, or none at all.

Analysis

All analyses were descriptive in nature. Quantitative data was analyzed using IBM SPSS Statistics (version 26; IBM Corp, Armonk, NY). The respondents were further classified according to their residence area based on regional incidence rate per 100,000 population in the region as defined by CDC as: low (<1500), medium (1500 or more and <3000), high (3000 or more) incidence areas. The Johns Hopkins' data¹⁰ from July 16 provided the incidence rate per 100,000 persons per region, and then the Johns Hopkins' data were merged with a cross-walk file from HUD USPS¹¹ to link COVID-19 occurrence rates with zip code data. These data were then merged with the survey data to determine COVID-19 risk using CDC guidelines.

RESULTS

Eighty-one AAN members responded to the survey, for a response rate of 10%. Of the 81 respondents, 63% were neurologists, 17% were residents, fellows or interns, 12% were advanced practice providers, 6% were medical students, and 1% were categorized as others. Compared with nonrespondents, advanced practice providers along with those who specialize in neurocritical care and vascular neurology and stroke are overrepresented, whereas medical students and those who did not mark a subspecialty were underrepresented.

In July, 38% of respondents indicated exposure to COVID-19 at work, 1% at home, and none outside of work/home (Fig. 1).

COVID-19 Exposure at Work: Outpatient Health Care Settings

When asked if they had seen any patients in an outpatient setting, there was no difference in proportion of respondents who had seen patients in January (76%) and in July (73%). Of the 58 respondents who had seen patients in an outpatient setting in July, 93% had seen at least 1 new patient and 77% had seen at least 1 follow-up patient. The duration of new visit was 31 to 60 minutes in 74% of new visits and 30 minutes or less in 89% of follow visits. Of the 58 respondents who had in-person visits in an outpatient setting, 11 had a clinical encounter (4 had 1 encounter, 7 had 2 to 5 encounters, and none had >5 encounters) with COVID-19 patients within last 2 weeks.

TABLE 1. A Comparison of Demographics of AAN Membership and Study Sample

Items	n (%)	
	Sample	AAN Membership
Member type		
Neurologist	52 (64)	13,930 (59)
Junior	12 (15)	4125 (17)
Student*	5 (6)	3897 (16)
Advanced practice provider*	10 (12)	1280 (5)
Intern	2 (2)	422 (2)
Total	81 (100)	23,654 (100)
Sex		
Men	42 (52)	12,713 (54)
Women	37 (46)	10,327 (44)
Missing	2 (2)	614 (3)
Total	81 (100)	23,654 (100)
Age category (y)		
<20	0† (0)	4 (0)
20-29	15 (19)	4830 (20)
30-39	21 (26)	7014 (30)
40-49	18 (22)	4090 (17)
50-59	16 (20)	3318 (14)
60-69	10 (12)	2716 (11)
≥70	1 (1)	1045 (4)
Missing	0 (0)	637 (3)
Total	81 (100)	23,654 (100)
Practice type		
Academic	26 (32)	6753 (29)
Missing	11 (14)	5770 (24)
Neurology group	11 (14)	3544 (15)
Hospital	15 (19)	2753 (12)
Multispecialty group	7 (9)	1730 (7)
Solo practice	8 (10)	1589 (7)
Other	1 (1)	826 (3)
Government	1 (1)	475 (2)
Industry	1 (1)	180 (1)
No clinical practice	0† (0)	34 (0)
Total	81 (100)	23,654 (100)
Primary subspecialty		
Missing*	9 (11)	6662 (28)
General neurology	26 (32)	6031 (25)
Epilepsy	5 (6)	1627 (7)
Vascular neurology and stroke*	12 (15)	1244 (5)
Neuromuscular medicine	6 (7)	1116 (5)
Movement disorders	4 (5)	1084 (5)
Other	2 (2)	804 (3)
Neuroimmunology and multiple sclerosis	1 (1)	803 (3)
Clinical neurophysiology	2 (2)	680 (3)
Sleep medicine	2 (2)	519 (2)
Neurocritical care*	5 (6)	514 (2)
Headache medicine	0† (0)	514 (2)
Behavioral neurology and neuropsychiatry	0† (0)	456 (2)
Neurohospitalist	2 (2)	377 (2)
Neuro-oncology	2 (2)	256 (1)
Neuro-ophthalmology*	2 (2)	140 (1)
Pain medicine	0† (0)	134 (1)
Geriatric neurology	0† (0)	111 (0)
Endovascular and interventional neurology	0† (0)	107 (0)
Neurogenetics	0† (0)	76 (0)
Traumatic brain injury	0† (0)	65 (0)
Neuroimaging	0† (0)	60 (0)
Neural repair and rehabilitation	0† (0)	57 (0)
Infectious diseases and neurovirology	1 (1)	51 (0)
Sports neurology	0† (0)	51 (0)
Palliative neurology	0† (0)	33 (0)

TABLE 1. (continued)

Items	n (%)	
	Sample	AAN Membership
Autonomic disorders	0† (0)	33 (0)
Neuro-otology	0† (0)	31 (0)
Neuroepidemiology	0† (0)	11 (0)
Neuromuscular pathology	0† (0)	7 (0)
Total	81 (100)	23,654 (100)
Region		
South	21 (26)	7698 (33)
Northeast	21 (26)	5996 (26)
Midwest	16 (20)	5330 (23)
West	23 (28)	4457 (19)
Total	81 (100)	23,481 (100)

Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

* χ^2 statistic is significant at the 0.05 level.

†This category is not used in comparisons because its column proportion is equal to 0 or 1.

AAN indicates American Academy of Neurology.

The distribution of PPE use in visits with COVID-19 patients according to maximum or second tier protection and proportion of times used is presented in Figure 2A. Maximum protection PPE were used by 16% of respondents either always or most of the times whereas 75% never used maximum protection. Second tier protection was always used by 55% of respondents always or most of the times. For visits with non-COVID-19 patients, second tier protection always used by 47% of respondents (Fig. 2B).

For procedures performed on non-COVID-19 patients in July in an outpatient setting, 28 respondents (51%) had performed a needle insertion, 5 (10%) had performed a lumbar puncture, and 3 (6%) had performed a catheter-based procedure. For procedures performed on COVID-19 patients in July in an outpatient setting, 1 respondent (2%) had performed a needle insertion and 1 (2%) had performed a lumbar puncture (data not displayed).

COVID-19 Exposure at Work: Inpatient Settings

When asked if they had seen any patients in an inpatient setting, there was no difference in proportion of respondents who had seen patients in January (75%) and in July (70%). Of the 53 respondents who had seen patients in an inpatient setting (in-person or by telemedicine), 50 respondents had seen at least 1 new patient in-person while 3 had done so only by telemedicine. Of the

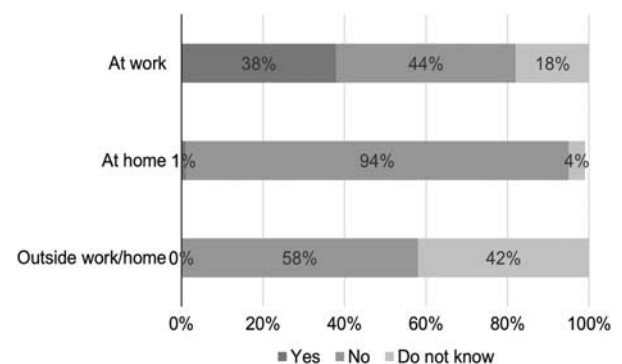


FIGURE 1. COVID-19 exposure during neurology practice.

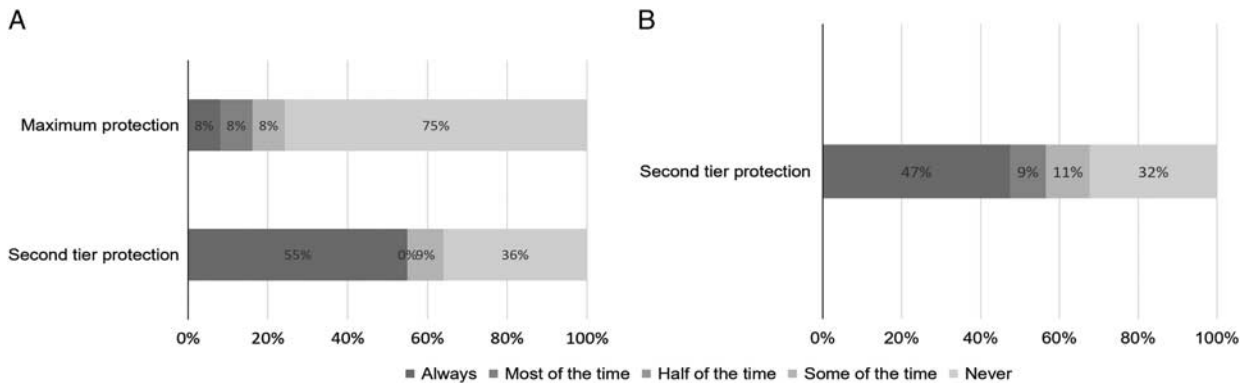


FIGURE 2. Outpatient use of personal protective equipment (A) for COVID-19 encounters, and (B) for non-COVID-19 encounters.

50 respondents who had in-person encounter in an inpatient setting, 33% or 66% of respondents reported at least 1 encounter (7 had 1 encounter, 13 had 2 to 5 encounters, and 13 had >5 encounters) with COVID-19 patients within the last 2 weeks.

The distribution of PPE use in visits with COVID-19 patients according to maximum or second tier protection and proportion of times used is presented in Figure 3A. Maximum PPE were always used by 56% of respondents and second tier protection was always used by 75% of respondents. For visits with non-COVID-19 patients, second tier protection was always used by 43% of respondents (Fig. 3B). Of the 49 respondents who had in-person visits with non-COVID patients in an inpatient setting, 25 (51%) used second tier PPE always or most of the time, whereas 13 (27%) never used it. Of the 32 respondents who had seen COVID-19 patients in an inpatient setting, 27 (84%) used second tier PPE always or most of the time, and 23% used maximum PPE always or most of the time, whereas 4 (13%) never used second tier PPE and 7 (22%) never used maximum PPE.

For procedures performed in July in an inpatient setting: in non-COVID-19 patients, 2 respondents (10%) had performed a lumbar puncture, 2 (10%) had performed a needle insertion, and 1 (5%) had performed a catheter-based procedure in intensive unit, and in COVID-19 patients, 1 respondent (5%) had performed a lumbar puncture (data not displayed).

Personal Risk Factors

All of the respondents were nonsmokers (not displayed). About half of the respondents (49%) had a normal body mass index, 35% were overweight, 11% obese, and 1% underweight.

Sixty-five percent of respondents reported a moderate amount of stress or less in the last 2 weeks, whereas 18% reported a lot of stress, and 17% a great deal of stress. The most frequent health issues respondents had that would increase their vulnerability to COVID-19 were hypertension (12%), asthma (6%), diabetes mellitus (5%), or cancer (2%). Similarly, the most frequent treatments or medications respondents used that would increase their vulnerability to COVID-19 were medications for hypertension (17%), for diabetes mellitus (7%), or for cancer (2%).

COVID-19-Related Medical Care in Respondents

Almost all respondents (99%) were not taking any medication prophylaxis for COVID-19 (data not displayed). A total of 12 (17%) of respondents were tested for COVID-19 in the last 2 weeks; 1 respondent tested positive for COVID-19. Most respondents (61%) did not experience any symptoms suggestive of COVID-19 symptoms in the last 2 weeks (data not displayed). Of the 28 who did experience at least 1 symptom, they most frequently reported symptoms were tiredness (32%) or diarrhea (8%). Of the 71 respondents, 4 (5%) received health care personally at an emergency department/urgent care or were hospitalized unrelated to COVID-19. One respondent received health care personally at an emergency department/urgent care or was hospitalized related to COVID-19 (data not displayed).

Comparison Between Respondents

Additional analysis was completed comparing neurologist (n = 51) to other neurology providers [advanced practice provider, resident, fellow, intern, medical student (M3/4) (n = 28)].

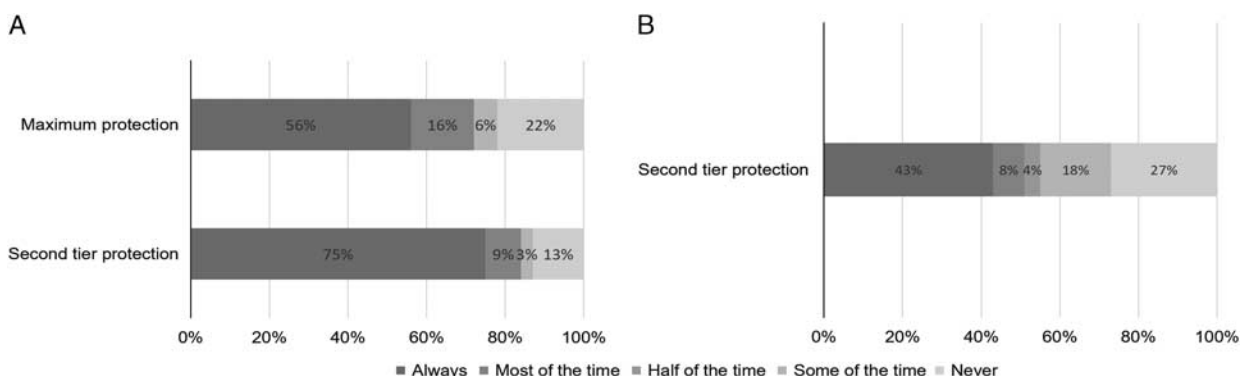


FIGURE 3. Inpatient use of personal protective equipment (A) for COVID-19 encounters, and (B) for non-COVID-19 encounters.

In both January and July, neurologists saw more patients in outpatient health care settings than other neurology providers.

Regional Exposure Risk According to Residence

Of the respondents, 46 were residing in low prevalence, 22 in medium prevalence, and 1 was residing in high prevalence region, and 10 resident addresses were not able to be matched to an incidence rate. No differences were seen between respondent according to residence.

DISCUSSION

Our survey found that ~38% of respondents (neurologist or neurology practitioners) indicated exposure to COVID-19 at work in July. Approximately, 12% of respondents had seen a COVID-19 in-person in outpatient setting whereas 32% of respondents had seen a COVID-19 in-person within inpatient setting. In July, more respondents saw COVID-19 patients in an inpatient setting than in an outpatient setting. When seeing COVID-19 patients, respondents within inpatient setting more frequently used both maximum and second tier PPEs. Only 3 procedures were performed on COVID-19 patients, 2 within inpatient setting and 1 in outpatient setting. Owing to the low number of respondents, results should be used with caution. In the survey, advanced practice providers along with those who specialize in neurocritical care and vascular neurology and stroke are overrepresented in respondents, whereas medical students and those who did not mark a subspecialty are underrepresented. Given the multiple differences, results should be used with caution. The results are reflective of early period of the pandemic and additional changes may have been occurred based on regional increase in cases, increase in access to PPE, and availability of additional medical data. Our survey does not provide data on redeployment of neurologists from outpatient practice to inpatient units to provide care of COVID-19 patients in the hospital.

The frequency of testing and confirmed COVID-19 in AAN members appeared higher than seen in general population. One of 5 respondents (17%) required testing for COVID-19 within the last 2 weeks (170 per 1000 population). The prevalence of testing among neurologists appeared to be much higher than the CDC reported national average of 1.6 tests per 1000 population (CDC Covid-Response Team)¹² with the maximum test administered in state of New York (excluding New York City) with 4.9 tests per 1000 population.¹² Of those tested, 1 (1%) respondent tested positive for COVID-19. The estimated incidence of COVID-19 was 1245 per 100,000 persons. One respondent received health care personally at an emergency department/urgent care or was hospitalized related to COVID-19. The overall cumulative COVID-19 hospitalization rate in United States was 120.9 per 100,000 in July.¹³

The risk of exposure to COVID-19 during neurology practice occurs from 3 groups of patients; patients with known infection, patients with suspected infection, and patients with undiagnosed infection. Patients who develop neurological disorders in advanced stages of COVID-19 are already identified by the institutional screening protocols. The biggest exposure risk is during evaluation of patients with undiagnosed COVID-19. Certain neurological symptoms such as headache, dizziness, impaired consciousness, acute cerebrovascular disease, ataxia, and seizure may precede the classic symptoms of COVID-19 such as cough, dyspnea, and fever.^{14,15} Approximately 20% of patients with COVID-19 do not develop clinical symptoms.^{16,17} Therefore, neurologists may see patients in clinics or hospitals who may have not have classic symptoms of COVID-19 and

thus not identified by screening protocols. Additional challenges in identifying COVID-19 in patients with neurological disorders is inability to get an accurate history of clinical symptoms due to underlying aphasia, dysarthria, and confusion. The delay in confirming COVID-19 is an additional impediment as using real-time reverse-transcription polymerase chain reaction from nasopharyngeal and oropharyngeal swab can take up to 8 h and 3 days for serological enzyme-linked immunosorbent assays. Further delay may be incurred if the specimen has to be sent to a laboratory outside the hospital also delay screening in clinics and hospitals.¹⁸ Repeat testing may be necessary due to poor quality of the specimen, limited patient specimens, or the inappropriate timing of specimen collection (too early or too late) during the infection process.¹⁹ It was surprising that maximum PPE was always used by only 84% of respondents during in patient clinical encounters with COVID-19 patients. The lack of use by other 16% may be due to lack of PPEs in medical facilities²⁰ or lack of definitive evidence that N95 masks provide additional protection compared with standard masks.²¹

It is likely that the risk of contracting COVID-19 is lower among neurologists than other medical specialties who are involved in evaluation of respiratory or infectious diseases and those who perform aerosol-generating procedures. A survey of 91 programs, which represented 24 specialties and 2306 residents residency program directors, was conducted inquiring about how many of their residents contracted COVID-19 from March 2 to April 12.²² At least 1 resident tested positive for COVID-19 in 45.1% of programs. There were 101 confirmed positive cases among resident physicians, and an additional 163 residents were presumed to be positive for COVID-19. Emergency medicine, anesthesiology, and ophthalmology residents were at highest risk. Our survey was performed when neurology services had already taken steps to prevent exposure to COVID-19.²² Most elective admissions for nonurgent purposes were canceled in early March, and epilepsy monitoring units were closed in both pediatrics and adult services. All urgent admissions and possible transfers were screened by phone for possible COVID-19 symptoms. Ambulatory staff were trained to screen all patients and those accompanying the patient for possible COVID-19 symptoms. Transition to teleneurology visits began for outpatient practices in early March for all new and established patients.

The data generated from this survey could enhance our knowledge of the factors that contribute to COVID-19 exposure during neurology practice and inform education and advocacy efforts to neurology providers, trainees, and patients in this unprecedented pandemic. As COVID-19 continues to spread across the United States and the world, more patients with COVID-19 may be seen by neurology providers, increasing exposure and risk of transmission. As the COVID-19 exposure risk is likely to change over time, the AAN could consider doing the survey again, and possibly at regular intervals. The manuscript does not constitute an official position of the AAN.

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