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NEUROLOGY IN PRACTICE

Maintaining stroke care in the era of Covid-19: A review of practices implemented in the Gulf and Iran

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Abstract

A panel of stroke experts from the Gulf and Iran region convened a consensus meeting to discuss how the Covid-19 pandemic has affected stroke care in the region. Lower stroke admissions were observed locally, but acute stroke care has largely been maintained in their centres despite the challenges of staff and resource shortages, and public fear of the virus. This article provides a snapshot of the pandemic in the region, its impact on local stroke care, highlights the approaches and practices shared between panellists in order to protect stroke care pathways during this uncertain period, and provides a guideline that is simple and easily adaptable to different locations. The intent is to protect stroke care pathways through Covid-19 risk stratification, infection control measures, and ensuring that all stroke patients have a full Covid-19 diagnostic assessment. Opportunities for increasing the use of telemedicine to reduce physical contact between patients and healthcare workers is also discussed.

INTRODUCTION

On 11 March 2020, the World Health Organization (WHO) declared the pandemic of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and the associated illness, Coronavirus Disease 2019 (Covid19).[1] The virus has rapidly spread causing economic and social disruption, with lockdowns, travel restrictions, and social distancing. Most importantly, healthcare systems have been heavily burdened as Covid-19 patients take up resources. As of 22 June 2020, nearly 9 million cases have been confirmed, with 465,740 deaths globally[2] and numbers increasing daily. The shift of resources has led to challenges in conducting vital diagnostic tests, treating, and admitting nonCovid-19 patients and numerous elective procedures have also been cancelled. Thus, the nonCovid-19 patients may be the untold victims of the pandemic.[3] The situation is especially dire for stroke patients, considering the hyper-acute nature of stroke care and its reliance on timely admission, diagnostics, and therapy.

Reductions in stroke admissions were observed in numerous centres. When comparing data from 2020 to 2019, Chinese stroke centres reported 37.9% fewer stroke admissions during the pandemic. A survey of these centres found 93.83% of the respondents felt that the drop in admissions was due to patients' fear.[4] Further illustrating the unease in the population, is a report from Catalonia, Spain, which reported a drastic (360%) increase in daily calls to Emergency Medical Services (EMS) but a decrease in stroke code activations.[5] Although there is a high degree of public concern, we run the risk of drowning out the critical stroke care concept of "time is brain" in the current Covid-19-dominated environment.

Stroke care in the Middle East and North Africa (MENA) region is still under development. The number of stroke units in the region has increased from 16 to 96 between 2013 and 2018.[6] This is certainly positive, as specialised stroke units have been demonstrated to show improved patient outcomes regionally.[7,8] Despite the potential for improvement, the rate of admission to stroke

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units was found to be lower in MENA patients when compared to non-MENA patients (21.3% vs 49.5%).[9] If the trends seen elsewhere apply to this region, then a patient population with an already low stroke centre utilisation may see a further drop-in specialised care. In short, the recent improvements to stroke care in the region are jeopardised during this crisis.

In response, a panel including experienced stroke specialists from the region was convened by the Angels Initiative[10] to discuss the Covid-19 pandemic and its impact on stroke care in their centres. The panel formulated recommendations for maintaining stroke performance indicators during pandemics. It is felt that implementation of these recommendations will be helpful during an expected second wave of Covid-19 and can be applicable to future respiratory virus outbreaks. This article highlights the key discussions and takeaways from the meeting.

METHODS

An online virtual consensus meeting was held on 16 May 2020 and covered the following topics:

- Overview of COVID-19 in the Gulf and Iran region and its impact on stroke care in regional centres
- Actions that can be taken to modify stroke care pathways during pandemics while still maintaining a high level of care

Data for this article was taken from the meeting discussion, information shared by the panellists and a literature search. The literature search was performed using MEDLINE (by PubMed) and accessing international health agencies' and stroke societies' public websites. The articles included were prospective observational studies, reviews, clinical guidelines, evidence-based consensus recommendations/guidelines, and government/ stroke society guides and newsfeeds. All articles were in the English language and available online. Data up to 30 Jun 2020 were considered for inclusion. Acute stroke admission and recanalization numbers from the Central Stroke Unit in Oman were taken from Al Shifa electronic medical records system and the central stroke unit code stroke entry book for the periods of Jan - Jun 2019 and Jan - Jun 2020.

IMPACT OF COVID-19 IN THE GULF AND IRAN REGION ON LOCAL STROKE CENTRES

WHO has registered 875,153 confirmed Covid-19 cases and 17,603 deaths in Iran, Pakistan, and the Gulf Cooperation Council (GCC) countries, as of 30 Jun 2020. Community transmission of the virus has been noted in Iran, Qatar, the United Arab Emirates (UAE), and Oman.[2] Iran, an early epicentre of the pandemic, had the highest absolute number of cases and deaths of these countries.

All panellists confirmed an impact on stroke services during the pandemic. Factors affecting stroke centres included:

- patient fear and unwillingness to seek treatment for non-disabling symptoms
- delays in transfers and difficulty finding beds due to virus status requirements
- conversion of stroke unit hospitals to primarily Covid-19 centres
- redeployment of stroke specialists to Covid-19 centres
- infection control precautions required before approaching patients
- medical professionals' fear of the virus leading to difficulty in performing rehabilitation or supplementary diagnostics

REGIONAL STROKE CARE DURING THE COVID-19 ERA

Of the 7 (6 in the Gulf and Iran region, 1 in Canada) comprehensive stroke centres represented, 4 (2 in UAE, 2 in Iran) were designated as Covid-19 hospitals at the time of the meeting. However, regardless of a hospital's Covid-19 status, all centres faced challenges and increased demands. Fortunately, stroke care pathways were generally maintained in the region.

In Oman, as of 30 Jun 2020, there were 437 hospitalised Covid-19 patients, of which 117 were admitted to intensive care units (ICUs).[11] If the numbers continue to rise, then this will constitute a burden on the local health system as happened in many other countries around the globe. In Qatar, although it was not converted, approximately 80% of the stroke team, from the main stroke unit at Hamad General Hospital (HGH), was redeployed to Covid-19 centres. The resulting staff shortages led to an increased workload with the risk of burnout, and some lower-acuity services such as transient ischaemic attacks (TIA)/non-severe stroke clinics, stroke prevention, and rehabilitations being cancelled or modified, however, 24/7 acute stroke care was maintained.

In line with other countries, a reduction in stroke admissions was also observed. At the Central Stroke Unit in Oman, there was a decrease in admissions in 2020 in Mar - Apr from Jan - Feb,

but in May and Jun, admissions trended upward compared to Jan - Jun 2019, there was a ~20% reduction in admissions to the stroke centre for this period in 2020. Despite this, thrombolysis numbers increased in 2020 (35 in 2020 vs 20 in 2019), with thrombectomies relatively unchanged. This may be due to stroke awareness campaigns in recent years. (Figure 1)

Unlike in Muscat Imam Hossein Hospital in Tehran was converted early on to a Covid-19 hospital. A comparison of stroke admissions during the Covid19 period (15 Feb 2020 15 Apr 2020) with both the immediate preCovid19 period (15 Sep 2019 15 Feb 2020) and the same period in 2019 (15 Feb – 15 Apr) revealed an approximately 40% decrease.[12] During the pandemic, the treatment of stroke did not appear to differ, as there were relatively unchanged rates of thrombolysis and thrombectomies with 9 of 23 ischemic stroke patients receiving recanalization therapy. A noticeable change was the increased proportion of severe strokes at Imam Hossein stroke centre, where 61.3% of patients during the COVID-19 period had a National Institute of Health Stroke Scale (NIHSS) >20, compared to 59.2% in the pre-Covid-19 period and 28.0% during Feb – Apr 2019.[12] When the 31 stroke patients during the pandemic were split into Covid-19 positive and negative subgroups, 90% of the Covid-19+ stroke patients had severe strokes, compared to 47.6% of non-Covid-19 stroke patients. Covid-19+ stroke patients on average were older (75.60 ± 9.54 years) than non-Covid-19 stroke patients (60.86 ±18.45 years). There was also a difference in the type of stroke, with Covid-19+ stroke patients having a greater proportion of large vessel ischemic strokes than negative patients (70.0% vs 23.8%)[1].

In addition, a case series of 22 Covid-19+ ischemic stroke patients from Dubai, found that 84.2% had a major vessel occlusion, and on average, were young (46.3 ±11.1 years).[13] Four patients were eligible for acute recanalization treatment. Though interesting, these findings must be considered with the characteristics of stroke patients in the wider Middle East. They are slightly younger, have slightly more severe ischemic strokes, with large vessel stenosis as a common aetiology.[9] Non-lacunar strokes in general are prevalent in the region.[14] The sample sizes of the studies from Dubai and Tehran were small, so further investigation is needed to determine if Covid-19 stroke patients have typical features.

RECOMMENDATIONS FOR MAINTAINING STROKE CARE DURING PANDEMICS

It is important to develop modified stroke treatment protocols, which prevent both patients and healthcare workers from contracting Covid-19 and provide a high level of care to patients during the pandemic. Important themes considered when modifying a protocol (across the phases of stroke care) are:

- Stratifying Covid-19 transmission risk
- Using personal protective equipment (PPE)
- Running all available Covid-19 diagnostics
- Utilising separated physical pathways in hospital
- Increasing the use of tele stroke systems

Pre-hospital phase of stroke care

Covid-19 risk stratification

This is an essential step to determine how an incoming stroke patient is triaged. The panel

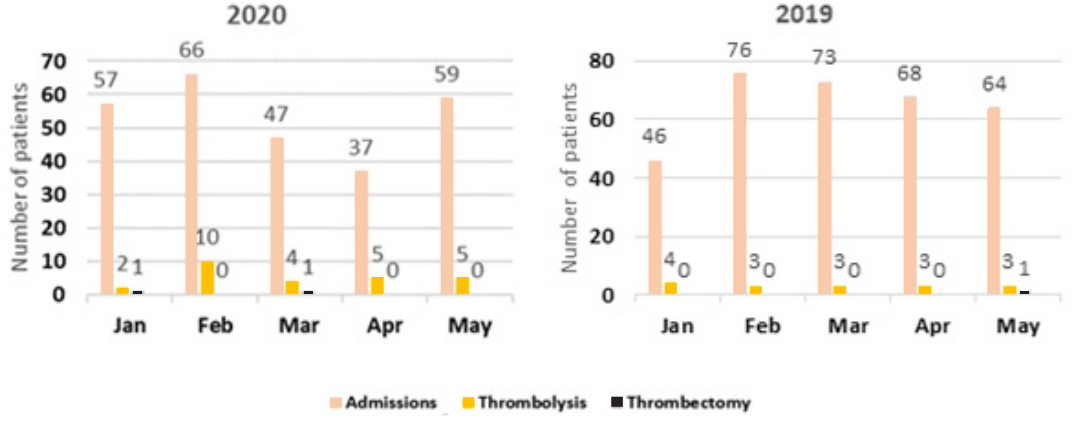

Figure 1. Admission and recanalization at Central Stroke Unit, Oman in 2020 vs 2019 (Jan – Jun).

recommended a cautious approach, with all patients considered potentially infected with SARS-CoV-2 until proved otherwise. This is especially relevant as infectivity of SARS-CoV-2 in an asymptomatic carrier was reported in a familial case cluster[15] and some tests in the USA found 56% of positive patients were asymptomatic at the time of testing.[16]

Considering asymptomatic transmission, patients should be categorised as either low or high risk for Covid-19 based on symptoms and history. Additional information should be gathered by first responders in parallel to stroke prenotification details as listed in Table 1. If there is any doubt about the history provided, if the infection control assessment is not done, the patient cannot communicate, or examination features are suggestive of an alternative (nonstroke) diagnosis[17], the patient should be stratified as high risk. This requires the patient to pass through a new pathway with infection control measures added to regular stroke protocols.

Early guidance only considered international travel for screening. However, increased local transmission means a patient's "travel history" should be reframed in the context of living in or visiting areas of widespread community transmission or attending events where these transmissions are known to have occurred.[18] Regardless of the risk level, all patients should be required to wear a surgical mask before close contact is made with health care professionals.

Personal protective equipment

Any hospital staff expecting to be in direct contact with patients should be prepared to don personal protective equipment (PPE). There are 3 levels of protection as listed in Table 2. For high risk patients, the precaution level adopted depends on the procedures performed.[17] Enhanced protection is required, especially medical grade N95/FFP2 masks for aerosol-generating procedures (e.g., intubation and suctioning) which can generate a fine mist of bodily fluids able to penetrate regular surgical masks. For confirmed COVID-19 patients, team members may consider using these masks at all times. In addition to PPE, all staff must practice diligent hand hygiene and, whenever possible, maintain physical distance from patients. For low risk patients, standard precautions are to be adopted.

Covid-19 diagnostics upon admission to the emergency department

The final decision regarding the patient's Covid-19 risk stratification should be made at the entry to the emergency department (ED). A nasopharyngeal swab test should be performed on all incoming patients regardless of their assessed risk. Although it may cause some admission delay, test results may be needed when transferring patients between departments or facilities. Rigorous pre-hospital Covid-19 risk stratification practices can help speed this step by eliminating the need for a repeat history or temperature to be taken.

Acute phase of stroke care

Separate physical pathways in hospital

Depending on local infrastructure and burden of Covid-19 patients, the ED should be split into high risk areas for Covid-19 and low Covid-19 risk areas. High risk patients will follow a pathway,

Table 1: Pre-notification details to be collected in the Covid-19 era

Standard stroke details[18]	Infection control assessment[16, 17]
– Patient identifiers (as allowed by local privacy laws) to expedite the registration – Signs of stroke apparent and visible in patient, including face, arm, speech involvement – Signs of stroke onset time if witnessed, and last seen well time if not witnessed – Current condition of the patient having a stroke, and changes in their condition since the symptoms started – Current medications and other health problems, if known – Contact details of witness – Advanced care directives if available	– Assessment of symptoms of infectious illness or history of symptoms within the past 14 days (fever, cough, chest pain, dyspnea, headache, myalgia, emesis, diarrhea) – Close contact with a confirmed COVID-19 case or with someone having above infectious symptoms – Residence in or visit to an international or domestic area/event of high community transmission or close contact with someone who does/has.

Table 2: Levels of precaution and personal protective equipment (PPE)

High Risk Patients		Low Risk Patients
Airborne precautions	**Contact and droplet precautions**	**Standard precautions**
– disposable latex gloves – medical-grade N95/FFP2* mask – full-sleeved disposable gown, waterproof or with an apron – surgical cap – full face respirator	– disposable latex gloves – surgical mask – full-sleeved disposable gown – surgical cap – eye protection	– disposable latex gloves – surgical mask – full-sleeved disposable gown

which should be adhered to as consistently as possible, but may be more ad hoc, based on the current burden of patients. Low risk patients will follow, as closely as possible, the usual (pre-Covid-19) stroke pathway, with some modifications. Once designated, the low risk pathway must be strictly followed as planned, with clear signage placed, and contamination avoided.[20] In outbreak scenarios, setting up these pathways should be done early on. Each pathway should include dedicated consultation rooms, computerised tomography (CT)/magnetic resonance imaging (MRI) equipment, and angiographic suite. Figure 2 is an illustrative model of protected and regular pathways that can be adopted during a pandemic.

Separate CT scanners for the pathways are especially important in acute stroke care. For low risk patients, it will reduce their chance of exposure and keep their door-to-imaging times to a minimum, thus increasing the likelihood that, in eligible patients, the American Heart Association targets[21] of <60 min from doortoneedle for intravenous recombinant tissue plasminogen activator (rt-PA) thrombolysis and <90 min from door-to-puncture for mechanical thrombectomy are met. Although high risk patients will compete with a higher volume of patients seeking CT scans, maintaining protocols for prioritising stroke patient access to imaging equipment can help prevent increased doortoimaging times. When equipment is allocated, newer, faster scanners could be assigned to higher volume pathways or, alternatively, EDs could look into acquiring portable scanners.[22]

Acute stroke patients will reach the CT scanner before the laboratory Covid-19 test result is available. Currently, the detection standard used for SARS-CoV-2 is a reverse- transcriptase polymerase chain reaction (RTPCR) test of samples from a nasopharyngeal swab. Infection cannot be ruled out based on a single negative test result[23] and some tests have had an initial falsenegative rate of 12.5%.[24] A chest CT should be done to help detect infection by visualising typical pulmonary features of Covid-19 (mainly ground glass opacities and consolidation[3,25]). RTPCR is still necessary, as these features are only indicative of viral pneumonias, not specifically Covid19.[3] A study including patients undergoing a head CT, added an additional chest CT to detect Covid19 and found a sensitivity of 85.7%.[26] As stroke patients often need to undergo brainimaging procedures, the panel recommended adding a high-resolution chest CT for all stroke patients as an early indicator of potential infectiousness. If local resources are limited, then priority for the additional chest CT should be given to patients in the high-risk pathway. Furthermore, adding this procedure to the imaging panel may save a return trip to imaging and provide a baseline of pulmonary status should the patient later be confirmed as SARSCoV-2 positive.

High risk patients could have their consultation with the stroke neurologist in accordance with the Covid-19 stroke care model set by a California stroke centre[27], which increased tele stroke consultations in the ED. If systems are available, the consultation be held with a primary ED physician and a nurse wearing PPE. The stroke consultant will guide the assessment from an isolated area, thus avoiding potential virus exposure and saving a set of PPE. If tele stroke is not available, the stroke consultant will don PPE and join the primary care team in the consultation room. The stroke consultant will maintain physical distance from the patient except for tests such as grip strength or sensation examination.[27] Treatment decisions will be made according to standard hospital protocol during the stroke consultation.

For high risk patients requiring thrombectomy,

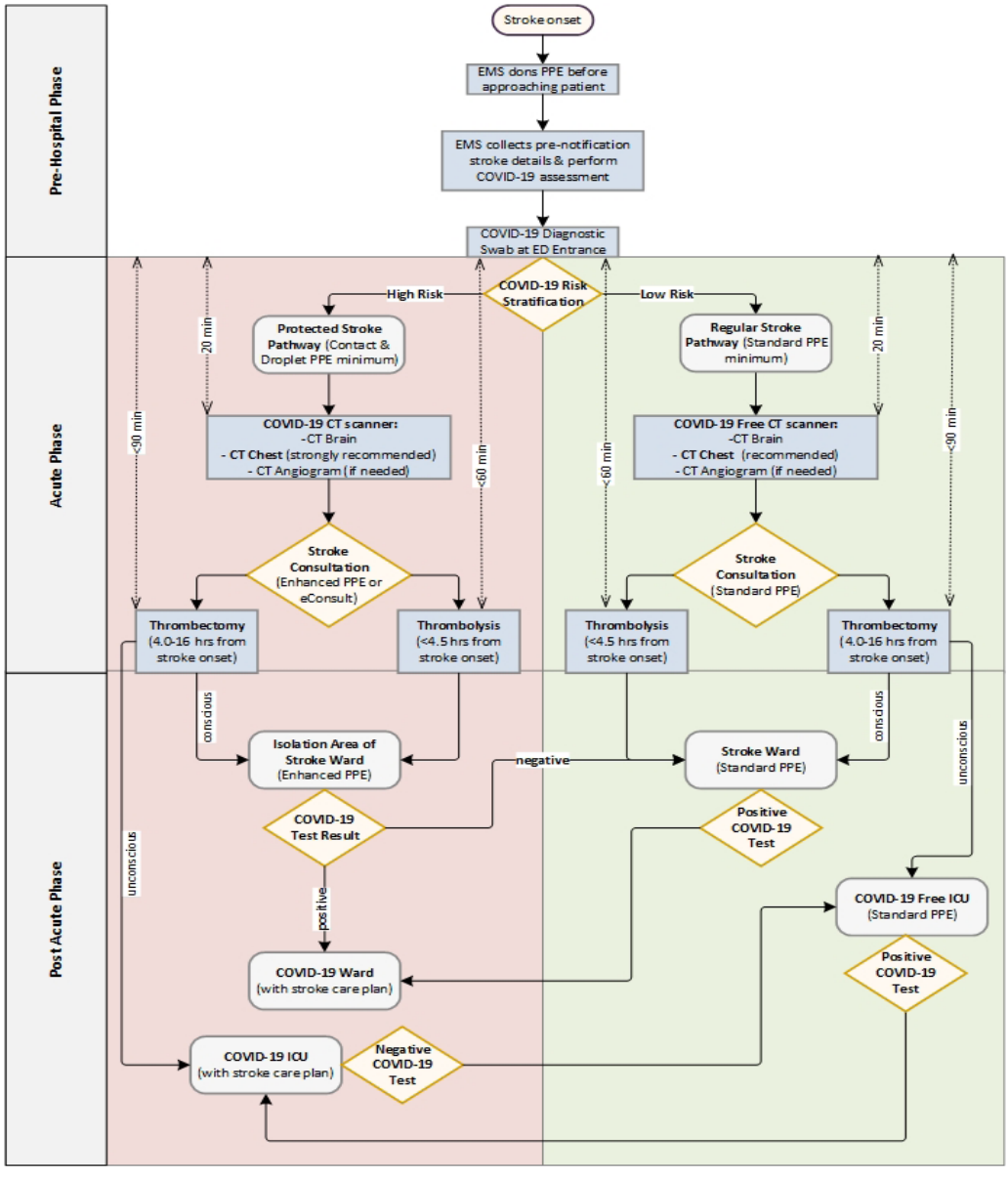

Figure 2. Stroke care pathway modifications during Covid-19 pandemic

EMS: emergency medical services, PPE: personal protective equipment, ED: emergency department, CT: computed tomography

the stroke consultant will contact the endovascular team and advise them, before transfer, of the patient's diagnosis and risk status. The endovascular team will then don appropriate PPE. After the procedure is completed, the patient will be transferred to a designated area and the angiosuite decontaminated. For high risk patients requiring thrombolysis only, the attending nurse or physician will administer rt-PA, with pharmacist maintaining physical distance, and the patient then transferred to the designated area. For low risk patients undergoing either therapy, standard post-treatment hospital procedures will be followed.

Post-acute phase of stroke care

The final in-hospital destination for high risk patients without serology test results can depend on local protocols. Some stroke wards have set the goal remaining completely Covid-19 free.[5,22] This can be achieved by having waiting beds outside the ward. Other centres have set up isolation areas within the ward for these patients.

If patients test negative, they are admitted to the stroke ward or ICU, while a confirmed Covid-19 positive patient may be sent to a designated ward or hospital. Patients transferred away from stroke centres will lack specialised post-stroke care, but even patients isolated within a stroke ward may have reduced checks, rehabilitation sessions, and follow-up diagnostics due to infection control measures and reluctance to treat Covid-19 patients.

A potential solution to this problem is already at hand, and that is the increased implementation of telemedicine in postacute stroke care. Although it is widely used to enhance the hub and spoke model of hyperacute care and extend specialist expertise into underserved regions[28], its usefulness outside of acute settings was debated even amongst the panel. However, considering the potential paradigm shift with regard to remote working that has been brought on by lockdowns, it is worth considering as a tool to maintain stroke care. In the short term, and with limited technical complexity, simple tablet-to-tablet connections could be used for rehabilitation sessions. Virtual rounds could be started in the stroke ward to reduce contact between team members and patients and reduce PPE usage. In these rounds, a designated team member would bring a tablet on a cart into the patient room and conduct necessary physical examinations while other team members connect via a teleconferencing platform.[29] Telemedicine also allows healthy, quarantined team members to work from isolation.

A brief report published in January 2020 found that 66.7% of TIA and minor stroke patients attending EDs, would prefer inpatient treatment rather than discharge with rapid outpatient follow-up.[30] This figure is jarring considering the decreases in stroke admissions seen globally mere months after publication. To allay patients' fears and free hospital resources, the panel supported early release of patients so long as there is no serious impact to their health and safety.

Expansion of telemedicine outside the hospital setting

A New York-based health network experienced a massive switch to telemedicine, and a corresponding decline (>80%) to in-person visits during March - April 2020 while >70% of outpatient volume in the network was handled virtually.[31] This growth is significant, but another report from New York found that many potential patients lacked reliable internet connectivity and were hindered from accessing video telemedicine.[32] While potential access barriers must be considered, the example in New York showed that video telemedicine can be expanded in a short time period and is a feasible way of offering physically isolated care to a large number of patients. Fortunately, the GCC countries have a high percentage of population with internet access.[33] Additionally, the large expatriate community[34] in these states often live alone creating a need for follow-up. At Hamad General Hospital in Qatar, weekly follow-up of discharged stroke patients has been conducted virtually during the pandemic. Virtual consultations should be expanded in the areas of outpatient TIA clinics and stroke prevention, outpatient follow-up and rehabilitation, video and/or data link between EMS and hospital.

CONCLUSION

The Covid-19 pandemic has dominated the public sphere for months and has had far-reaching consequences that will be felt in the foreseeable future. In the field of stroke care, the full extent of these consequences is, as of yet, still unknown. The virus did prevent stroke patients from seeking out treatment in the Gulf and Iran region. However, for patients who did come in for treatment, a high level of care was maintained by our colleagues across the region despite the challenges faced. Acute ischaemic stroke care in particular has been maintained in the era of Covid-19, with thrombolysis and thrombectomy rates remaining relatively stable at our centres. This was achieved through effective planning, rational and simple approaches to infection control, communication, and collaboration. The practices highlighted in this article can easily be adopted in other regions to help ensure acute stroke care is maintained.

There are still challenges to overcome, especially in maintaining standards of care for TIAs and in the post-acute, and rehabilitation stages of ischaemic stoke care. Furthermore, additional knowledge of the characteristics of strokes in Covid-19 patients will provide care teams valuable information to prepare their units for a second wave of the disease. Until a vaccine is developed, it is our duty as stroke care specialists to adopt the best practices to protect our patients and to continuously advocate on their behalf in the face of uncertainty and increased demand for health care resources.

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REFERENCES

1. World Health Organiszation. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020
2. World Health Organization. Coronavirus disease (COVID-2019) Situation Report - 162. 2020. https://www.who.int/docs/default-source/coronaviruse/20200630-covid-19-sitrep-162.pdf?sfvrsn=e00a5466_2
3. Rosenbaum L. The untold toll — The pandemic's effects on patients without Covid-19. *N Engl J Med* 2020;382:2368-71.
4. Zhao J , Li H, Kung D, *et al*. Impact of the COVID-19 epidemic on stroke care and potential solutions. *Stroke*. 2020:51:7: 1996–2001
5. Rudilosso S, Laredo C, Vera V, *et al*. Acute stroke care is at risk in the era of COVID-19: Experience at a comprehensive stroke center in Barcelona. *Stroke* 2020; 51(7):1991-5.
6. Khan M, Al-Rukn S, Alhazzani AA, *et al*. Changing the face of stroke care in the Middle East North Africa region. *J Neurol Sci* 2020;412:116727
7. Mehrpour M, Taghipour S, Abdollahi S, *et al*. Positive impact of stroke unit establishment on patient recovery in Firoozgar hospital. *Med J Islam Repub Iran* 2016;30:446
8. Ibrahim F, Akhtar N, Salam A, *et al*. Stroke thrombolysis protocol shortens "door-to-needle time" and improves outcomes-experience at a tertiary care center in Qatar. *J Stroke Cerebrovasc Dis* 2016;25:2043-6.
9. Rukn SA, Mazya MV, Hentati F, *et al*. Stroke in the Middle-East and North Africa: A 2-year prospective observational study of stroke characteristics in the region-results from the safe implementation of treatments in stroke (SITS)-Middle-East and North African (MENA). *Int J Stroke* 2019;14:715-22.
10. Angels Inititative. Https://www.Angels-initiative.Com/.
11. Oman Ministry of Health. Daily COVID-19 statement #124. 2020. https://twitter.com/omanimoh/status/1277890362527363077?lang=en
12. Mehrpour M, Shuaib A, Farahani M, *et al*. Express: COVID-19 and stroke in Iran; a case series, and effects on stroke admissions. *Int J Stroke* 2020:1747493020937397
13. Khan M, Ibrahim RHM, Siddiqi SA, *et al*. Express: COVID-19 and acute ischemic stroke-a case series from Dubai, UAE. *Int J Stroke* 2020:1747493020938285
14. El-Hajj M, Salameh P, Rachidi S, *et al*. The epidemiology of stroke in the Middle East. *Eur Stroke J* 2016;1:180-98.
15. Bai Y, Yao L, Wei T, *et al*. Presumed asymptomatic carrier transmission of COVID-19. *JAMA* 2020;323(14):1406-7.
16. Arons MM, Hatfield KM, Reddy SC, *et al*. Presymptomatic SARS-COV-2 infections and transmission in a skilled nursing facility. *N Engl J Med*. 2020;382:2081-90.
17. Khosravani H, Rajendram P, Notario L, *et al*. Protected code stroke: Hyperacute stroke management during the coronavirus disease 2019 (COVID-19) pandemic. *Stroke* 2020;51:1891-5.
18. Pedicelli A, Valente I, Pilato F, *et al*. Stroke priorities during COVID-19 outbreak: Acting both fast and safe. *J Stroke Cerebrovasc Dis* 2020:104922
19. Boulanger JM, Lindsay MP, Gubitz G, S, *et al*. Canadian stroke best practice recommendations for acute stroke management: Prehospital, emergency department, and acute inpatient stroke care, 6th edition, update 2018. *Int J Stroke* 2018;13:949-84.
20. Qureshi AI, Abd-Allah F, Alsenani F, *et al*. Management of acute ischemic stroke in patients with COVID-19 infection: Report of an international panel. *Int J Stroke* 2020:1747493020923234
21. American Heart Association. Target: Stroke phase III. 2020. https://www.heart.org/en/professional/quality-improvement/target-stroke/introducing-target-stroke-phase-iii
22. Baracchini C, Pieroni A, Viaro F, *et al.* Acute stroke management pathway during coronavirus-19 pandemic. *Neurological Sciences* 2020;41:1003-5.
23. Hong KH, Lee SW, Kim TS, *et al*. Guidelines for laboratory diagnosis of coronavirus disease 2019 (COVID-19) in Korea. *Ann Lab Med* 2020;40:351-60.
24. Li Y, Yao L, Li J, *et al*. Stability issues of RT-PCR testing of SARS-COV-2 for hospitalized patients clinically diagnosed with COVID-19. *J Med Virol* 2020;92(7):903-8.
25. Long C, Xu H, Shen Q, *et al*. Diagnosis of the coronavirus disease (COVID-19): RRT-PCR or CT? *Eur J Radiol* 2020;126:108961
26. Kwee RM, Krdzalic J, Fasen B, *et al*. CT scanning in suspected stroke or head trauma: Is it worth to go the extra mile and include the chest to screen for COVID-19 infection? *AJNR Am J Neuroradiol* 2020;41(7):1165-9.
27. Meyer D, Meyer BC, Rapp KS, *et al*. A stroke care model at an academic, comprehensive stroke center

during the 2020 COVID-19 pandemic. *J Stroke Cerebrovasc Dis* 2020:104927
28. Zerna C, Jeerakathil T, Hill MD. Telehealth for remote stroke management. *Can J Cardiol* 2018;34:889-96.
29. Al Kasab S, Almallouhi E, Holmstedt CA. Optimizing the use of teleneurology during the COVID-19 pandemic. *Telemed J E Health*. 2020;26(10):1197-8.
30. Chang BP, Cornelius T, Willey J, Edmondson D, *et al*. Are patients afraid to go home? Disposition preferences after transient ischaemic attack and minor stroke. *Emerg Med J* 2020;37(8):486-8.
31. Mann DM, Chen J, Chunara R, *et al*. COVID-19 transforms health care through telemedicine: Evidence from the field. *J Am Med Inform Assoc* 2020;27(7):1132-5.
32. Watts KL, Abraham N. 'Virtually perfect' for some but perhaps not for all: Launching telemedicine in the bronx during the COVID-19 pandemic. *J Urol*. 2020:101097JU0000000000001185
33. World Bank. Individuals using the internet (% of population) - Kuwait, Oman, Bahrain, Saudi Arabia, United Arab Emirates, Qatar. https://data.worldbank.org/indicator/IT.NET.USER.ZS
34. Gulf Labout markets and Migration. Https://gulfmigration.Org/gcc-total-population-and-percentage-of-nationals-and-non-nationals-in-gcc-countries-national-statistics-2017-2018-with-numbers/.