

Stroke care during the COVID-19 pandemic: experience from three large European countries

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In order to cope with the exponentially increasing number of patients infected with SARS-CoV-2, European countries made enormous efforts to reorganize medical assistance and several diseases, including stroke, were particularly impacted. We report the experience of stroke neurologists from three European countries (Italy, France and Germany) that faced the pandemic at diverse time points and with different approaches, depending on their resources and healthcare system organization. Pre-hospital and in-hospital acute stroke pathways were reorganized to prioritize COVID-19 management and, in severely affected regions of Italy and France, stroke care was centralized to a limited number of centers, whereas the remaining stroke units were dedicated to patients with COVID-19. Access to acute stroke diagnostics and time-dependent therapies was limited or delayed because of reduced capacities of emergency services due to the burden of patients with COVID-19. A marked reduction in the number of patients presenting with transient ischaemic attack and stroke was noted in the emergency departments of all three countries. Although we only have preliminary data, these conditions may have affected stroke outcome. These indirect effects of the COVID-19 pandemic could negate the efforts of stroke neurologists over the last few years to improve outcome and reduce mortality of stroke patients. Although the SARS-CoV-2 infection rate is slowing down in Europe, the effects of ending lockdown in the next months are unpredictable. It is important for the European and world stroke community to share what has been learned so far to be plan strategies to ensure stroke care in the future and upcoming challenging times.

Introduction

As of 21 May 2020, the spread of the SARS-CoV-2 disease (COVID-19) has reached pandemic proportions, affecting more than 5 011 000 people worldwide [1]. Although the majority of cases were first reported in China, soon thereafter Europe became the disease epicenter with Spain and Italy leading the list of

countries with the highest number of COVID-19 cases, followed by France and Germany [1]. Since the beginning of the outbreak, European countries have adopted unprecedented measures such as large-scale application of social isolation, closing borders and nationwide lockdown at great economic cost. In addition, some extreme healthcare reorganizations have been implemented in several countries to fight against COVID-19, with different time lags and approaches, also in relation to national healthcare system organization and resources [2,3]. The impellent turning of health staff and hospital resources towards the

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COVID-19 emergency is inevitably leading to a serious impairment of normal medical care, particularly for diseases such as stroke, which is the second most common cause of death and the leading cause of disability [4]. Moreover, patients affected by COVID-19 have been hypothesized to be at increased risk of cerebrovascular events, probably due to the infection itself but also thrombotic complications [5–7]. A last element to be possibly considered is that patients with cerebrovascular diseases might also be at major risk of developing severe consequences from COVID-19 infections [8].

Herein, we report the experience and issues faced in stroke care organization in three European countries (Italy, France, Germany) during the COVID-19 pandemic. Although, as of today, the spreading curve of infection is slowly flattening, the COVID-19 pandemic is persisting in light of the end of lockdown. Reporting these experiences and highlighting problems may offer scope for discussion and for the development of potential strategies to ensure the adequate care of stroke patients in present and future challenging times.

The Italian experience

Beginning in mid-February 2020, the Italian authorities, particularly the regional health services (which in Italy have considerable autonomy from the central government on healthcare issues), had to manage a huge reorganization to direct resources towards the care of patients with COVID-19 [9]. On 21 May, the Johns Hopkins University counted 227 364 diagnosed COVID-19 infections and 32 330 (14.2%) deaths in Italy [1]. The rapid surge of COVID-19 cases seriously threatened the Italian health system. The intensive care unit (ICU) beds (about 5100 in the pre-COVID-19 era, with an occupation rate of 48.4%) became almost completely dedicated to patients with COVID-19. New ICUs were created, increasing the number of ICU beds to 8800 [10]. Protective measures, including indications for personal protective equipment and swab testing, were also progressively released according to regional indications. Many regions such as Lombardia, which is (with >10 million inhabitants) the largest in Italy, and also the region with the highest number of COVID-19 cases, decided to dedicate entire hospitals to the increasing needs of COVID-19-positive patients. In contrast, the care of non-COVID-19 diseases as well as non-urgent interventions and outpatient activities were greatly reduced or even stopped [11–13].

Acute stroke pathways were also completely redrawn: pre-hospital transportation was reorganized

to prioritize the needs of patients infected with SARS-CoV-2 and specific triage protocols were activated to assess and manage COVID-19 suspicion or infection. Many stroke units were closed to reallocate stroke physicians and nurses to the care of patients with COVID-19 or were even converted into COVID-19-positive wards [9,13,14]. Therefore, the usual hub-and-spoke system underwent an upheaval and all patients started to be primarily directed towards a limited number of centers where they were supposed to remain until discharge [11,13,14]. The result of this measure was to concentrate many stroke patients from huge areas in a limited number of hospitals, according to regional location and availability of beds and thrombectomy equipment. The Lombardia region retained 11 stroke centers from the previous 36 regionally certified stroke units. In the remaining centers, stroke management was limited to emergency care and patients were hospitalized in non-stroke-unit beds intermingled with other patients. In hub centers, dedicated areas for non-COVID-19 and COVID-19-positive patients were organized and adequate isolation measures for COVID-19-positive patients treated in stroke units were implemented. However, it was difficult to completely separate the pathways due to a considerable number of stroke patients identified as COVID-19 positive in the course of their hospital stay. Therefore, all stroke patients presenting to the emergency department were finally regarded as possibly infectious and were isolated. In addition to the usual computed tomography (CT) brain scan and CT angiography, these patients underwent chest X-ray or CT scan, extended biochemistry and infectious disease physician consultation. In acute care, the multidisciplinary team was maintained but with consultations being greatly limited by the physician shortage. Moreover, the availability of ancillary examinations such as brain magnetic resonance imaging or angiography for stroke patients was hampered by the need to keep diagnostic services protected and to manage patients with COVID-19.

Although this reorganization was accompanied by the effort of increasing the number of beds and the availability of personnel in some of these newly defined stroke hub centers, these changes probably influenced the availability of timely reperfusion therapies and emergency pathways for stroke patients [13–15]. Given the overcrowding of emergency rooms in these centers, the personnel shortage and the need for screening procedures as well as multidisciplinary consultations (i.e. infectious disease physicians, anesthesiologists), modified algorithms for patients presenting with large vessel occlusion were implemented, also including safety measures for the medical team and

patients. As yet, we have no data about the current onset-to-needle time in Italy, but it is likely that it has increased due to the heavy workload of the ambulance and emergency operators, time required for COVID-19 screening procedures and flooding of emergency rooms with patients with respiratory symptoms [13–16].

Post-stroke rehabilitation pathways were also centralized, due to the need to allocate wards to COVID-19 acute management, and rehabilitation care and services were divided into COVID-19-free and COVID-19-positive areas to guarantee adequate measures for patient isolation.

Similar to observations in cardiovascular disease, a stroke survey on 81 Italian stroke centers conducted by the Italian Stroke Organization [17] reported a reduction of about 26–30% of the hospitalization rate for minor stroke and transient ischaemic attack (TIA), and of about 50% of stroke acute therapies in comparison with the same period in 2019 [13,14,17]. Fear of in-hospital infection and advice from health authorities, media and doctors probably led patients with mild symptoms to stay at home. For this reason, information campaigns, encouraging patients to present early to the emergency room, have recently been increasingly implemented by stroke physicians [18].

Periodic follow-up visits, previously planned procedures and rehabilitation services for stroke survivors have been cut down in Italy due to restrictive measures implemented to reduce the spread of COVID-19 [9,13]. This raised the question of how to take care of patients who need periodic consultations and/or rehabilitation support. To overcome these limitations, some patients were contacted by telephone and telemedicine platforms were implemented to allow patient visits, thus avoiding direct contact with operators and waiting rooms [19–21].

The French experience

On 21 May 2020 in France, 181 700 infections and 28 135 (15.5%) deaths had been reported [1]. On 6 March, the French government launched the emergency plan called ‘*plan blanc*’ for hospitals. As a result, many hospital beds and staff were reallocated to patients with COVID-19 infection or suspected infection. In normal conditions, there are about 5000 ICU beds (with ventilator) in France. Due to the pandemic, the number of beds has rapidly increased to about 10 000 (7200 of which were dedicated to patients with COVID-19) and this increase was particularly important in some areas (where ICU bed numbers were increased by two- or threefold in a few weeks). Moreover, routine medical consultations were

cancelled. Each hospital had to define its own gradual charge depending on the number of patients with COVID-19 who were admitted. A rapid decrease in admissions for acute stroke was observed in almost all stroke units, including those eligible for recanalization therapies. However, at this stage, no systematic investigation is available for France [16]. As the spread of the epidemic was heterogeneous across the country, we observed various consequences. The most affected areas in France were the Great East, Paris and its suburbs and, to a lesser extent, the North. In these areas, some stroke units were initially entirely converted into ICUs. Although rarely, stroke neurologists and nurses were redeployed to work on these COVID-19-dedicated units. This redeployment was feasible because routine medical visits by chronic patients were cancelled and non-urgent hospitalizations were postponed, and also because of the help and availability of other neurologists and nurses from non-stroke neurological departments. Thus, at the beginning of the crisis, acute stroke patients were managed in non-dedicated beds intermingled with non-stroke patients, with daily visits from stroke neurologists and nurses and staff who were not stroke specialists. However, after a few weeks, in the majority of the stroke centers in Paris, stroke units were restored and divided into two separate areas, one for confirmed or suspected COVID-19 and one for non-COVID-19 stroke patients. It still remains to be determined whether this reorganization has had consequences in terms of delays, use of acute treatments and prognosis. At the end of March 2020, the French Neurovascular Society and French Society of Neuro-radiology published recommendations for management of patients with acute stroke in the context of the pandemic stating that acute stroke patients could be managed with thrombolysis and mechanical thrombectomy whether or not they had a COVID-19 infection [22]. Early in April, a joint press release (French Neurovascular Society and French Society of Cardiology) was published to alert all professionals and the population that management of acute stroke and acute coronary events was still organized and safe [23]. This campaign encouraged the population to alert emergency services in case of symptoms and explained that patients with and without COVID-19 were managed in separate hospitals or pathways in the same hospital, depending on the local environment.

The main concerns in France about the management of acute stroke patients were delays in calling emergency services after first symptoms, potential unavailability of anesthetists for patients requiring mechanical thrombectomy and delay in brain imaging

due to the need for disinfection procedures in contaminated CT rooms. In post-stroke management, as all routine visits were cancelled, physicians tried to contact patients by telephone or using telemedicine platforms. In addition, patients with a physical disability, speech disorders or cognitive impairment had difficulties in starting out-of-hospital rehabilitation due to the low availability of physiotherapists or speech therapists who had to close their offices. With regard to preventive drugs, the French government has allowed pharmacists to extend the delivery of drugs without the need for a new prescription. Finally, we observe that, fortunately, a large number of patients with COVID-19 can be discharged from the ICU. However, some patients have pulmonary and sometimes neurological (especially critical illness polyneuropathy and myopathy) symptoms and will require rehabilitation services, which may result in fewer beds being available for stroke patients. However, as non-urgent surgical interventions have been postponed, more post-surgery rehabilitation beds may be available.

The German experience

Before the SARS-CoV-2 pandemic, there were 28 000 ICU beds with 20 000 ventilator devices across all medical departments available for 83 million German inhabitants [24].

On 21 May, Germany reported 178 545 COVID-19 infections and 8172 deaths (4.6%) [1]. On 21 April 2020, 2908 patients with COVID-19 were being treated in ICUs with 2112 of them on ventilation. At that time, 31 244 ICU beds were available, with 12 623 (40.4%) beds being vacant [25]. The German Ministry of Health together with the Health Ministries of the 16 federal German states recommended on 16 March that all predictable treatments and operations should be postponed to increase ICU capacities for the expected rising numbers of patients with COVID-19.

Most emergency units were organized with specific separated rooms for patients with suspected COVID-19 infection. Routine medical consultations were cancelled and sick certificates are being requested by telephone or video calls, whereas general practitioners, neurologists, physiotherapists and speech therapists continued to assist patients. To the best of our knowledge, there was no major reorganization of the stroke care system in Germany, including 332 certified stroke units. Most stroke units were not closed or transformed into ICUs for patients with COVID-19, except for a few hospitals with stroke units that were temporarily not able to admit new patients due to a clustered COVID-19 infection among patients and medical staff [26].

On 2 April, the Cerebrovascular Diseases commission of the German Society of Neurology stated that acute treatment of stroke patients, secondary prevention and rehabilitation should be performed as 'smoothly and optimally' as possible [26].

To date, there are no articles published by German authors that have systematically investigated changes in TIA/stroke patients and treatment rates due to the SARS-CoV-2 pandemic. However, based on the shared experience of stroke neurologists in the Neurovascular Network Ruhr, covering 27 stroke units and nine neuro-interventional centers in a metropolitan area with 5.2 million inhabitants, a marked decrease of patients with TIA and minor stroke presenting at emergency room was noted. Some stroke centers also reported substantially decreased numbers of stroke patients receiving mechanical thrombectomy. In the Alfried Krupp Hospital Essen (neuro-interventional stroke center with approximately 1000 stroke patients per year), the number of patients presenting with TIA markedly decreased by 45% during the 5 weeks of lockdown from 16 March to 19 April compared with the two 5-week periods before the lockdown and the previous year's 5-week period. In contrast, neither the number of patients hospitalized for ischaemic strokes or intracerebral hemorrhages nor the number of patients receiving intravenous thrombolysis or mechanical thrombectomy changed. A publicity campaign initiated by the German Society of Neurology and German Stroke Society on 14 April about the so-called 'phenomenon of empty stroke units' in television and newspapers began to animate patients to seek medical help [27].

Due to more capacity in rehabilitation clinics and reduced authorization periods by health insurers, German stroke neurologists observed markedly reduced time intervals for transfer of acute stroke patients from stroke units directly to rehabilitation clinics.

Discussion

The current COVID-19 crisis has not only affected directly infected patients, but has also had multiple and profound implications for healthcare systems worldwide, in particular for patients with cardiovascular and cerebrovascular diseases, the two leading causes of death. In this article, we report the impact of the COVID-19 outbreak on stroke care in three different European countries. The three countries faced the pandemic with different time lags and with diverse organized healthcare systems. Although our report lacks systematic data in this exceptional and unpredictable situation, the experience in the three European countries may be helpful in order to be better prepared in future for new challenging situations.

In all three countries, the COVID-19 pandemic resulted in an adjustment of the emergency pathways and clinical inpatient and outpatient services [16]. In Italy and France, which were hit harder and, in the case of Italy, earlier compared with Germany, the most important organizational change for patients with cerebrovascular diseases was the centralization of acute stroke treatment in a limited number of hospitals and the partial reallocation of stroke unit beds into intermediate or intensive care beds. Multidisciplinary team management was also limited in the three countries.

Another important issue is that, contrary to what was expected from centralization strategies and from the observed increased risk of stroke in patients with COVID-19, the number of TIA and stroke patients accessing the emergency pathways was unanimously reported to be greatly reduced in comparison to the same period in 2019 in all three countries [6]. This phenomenon was observed in most European countries [16], as stated in the reports of the European Stroke and Neurological Societies (i.e. European Stroke Organisation, World Stroke Organization, European Academy of Neurology). The most likely explanation is that patients with mild stroke or TIA stayed at home due to the lockdown measures and general advice not to leave their house as doctors and media campaigns advised people to limit emergency room visits [13,28,29]. Furthermore, in Italy and France, older patients from nursing homes or rehabilitation clinics with very severe strokes and high pre-existing disability might also not be hospitalized because of the lack of stroke unit or ICU beds. Moreover, due to the contact ban and lack of social contact with relatives, neighbors and friends, symptoms like dysarthria, aphasia, neglect or mild paresis could be under-recognized by the patients themselves. Stroke signs might also not be diagnosed in patients hospitalized for pulmonary symptoms due to COVID-19 protective measures and missing neurological examination. Patients with cerebrovascular risk factors such as hypertension, diabetes, previous cardiovascular and cerebrovascular diseases are at major risk of severe COVID-19 illness and could have been hospitalized in ICUs for pulmonary problems, without a diagnosis of stroke.

In addition, access to time-dependent stroke therapy has been severely limited or delayed by reduced transportation capacities and busy emergency and CT services due to the burden of patients with COVID-19, mostly in those countries that could not be prepared in time for the exponentially rising numbers of patients with COVID-19.

Finally, outpatient visits by stroke survivors have been greatly reduced in France, Italy and Germany, whereas rehabilitation activities were continued

differently. Although several hospitals increasingly started to use telemedicine platforms, this type of assistance might not be the best solution for the generally old population of stroke patients and is probably insufficient to take care of the large population of patients with chronic cerebrovascular diseases.

This article is limited by lack of systematic data on acute stroke treatment and outcome and by the missing information on stroke care organization from other European nations, including Spain, which was amongst the earliest and most severely hit countries.

We believe that this contingent ‘suspended life’ [29] might result in a higher risk of stroke occurrence or recurrence and a lower adherence to secondary prevention and rehabilitation treatments, exposing patients to a higher risk of recurrent cerebrovascular events, increased disability and, last but not least, psychological consequences. This indirect effect of the COVID-19 pandemic could negate the effects of previous successful awareness campaigns designed to emphasize the importance of early presentation in case of acute neurological deficits and the efforts of stroke neurologists over the last few years to improve functional outcome and reduce mortality in stroke patients [14]. It is quite alarming that COVID-19 infection may shorten life expectancy in our most elderly stroke patient population, not only directly by the infection itself. For this reason, public awareness campaigns have been started by local initiatives and international stroke societies (i.e. European Academy of Neurology, European Stroke Organisation, World Stroke Organization, American Heart Association [AHA]) to emphasize the importance of early presentation in emergency rooms in the case of stroke symptoms.

A last important remark concerns the protection of patients but also medical staff from in-hospital COVID-19 infection [4,30]. Many health professionals were infected and died during the pandemic. A number of protection strategies were applied to prevent transmission of pathogens to health professionals or other hospital patients. Some hospitals were reorganized into COVID-19-positive and COVID-19-free areas to prevent unnoticed virus transmission among patients and health staff and to guarantee that a number of services continued to work. Screening strategies, hospital admission protocols and prevention measures were adopted in different ways according to national or local health policies. In contrast to Italy and France, which were among the first European countries to be infected and also suffered an earlier depletion of surgical masks and personal protective equipment, Germany adopted swab testing and protection strategies earlier in the course of the nationwide pandemic.

It is currently being discussed whether extensive screening is feasible and applicable to all stroke patients presenting at the emergency room and whether this will be useful when lockdown measures are relaxed in the upcoming weeks. Systematic screening procedures may introduce delays in admission to stroke units and investigations, in addition to requiring dedicated pathways, beds (i.e. single rooms) and waiting rooms.

In conclusion, the COVID-19 pandemic has resulted in great alterations in the acute and follow-up management of stroke patients. Although the control of infection is very important, it is crucial that stroke physicians are able to continue caring for their patients. As pointed out before, it is important to balance the demands of a global pandemic, limiting nosocomial virus spreading and optimizing acute care resources, and the maintenance of access to outpatient and inpatient stroke services [4]. Hospital administrators and health system authorities should be reminded that stroke care is dependent on specialized and multidisciplinary teams and stroke physicians should be not removed from the care of stroke patients. Another challenging task for stroke physicians is to ensure care for ongoing medical and non-medical secondary prevention and rehabilitation therapy for their patients.

Political leaders and health authorities should get into or stay in close contact with physicians to maintain the best possible treatment of acute stroke patients and stroke survivors by careful planning strategies without forgetting investment in research, education and training [4]. The results from ongoing prospective and retrospective observational studies in stroke patients will be helpful to further direct stroke treatment in this challenging situation. Given the heterogeneous strategies applied in different countries, we recommend information and scientific exchanges by using existing and establishing new national and international stroke networks [16].

Disclosure of conflicts of interest

Anna Bersano serves as co-chair of the European Academy of Neurology Stroke Management Panel, on the editorial boards of *BMC Neurology* as associated editor and on the Editorial Board of *International Journal of Molecular Sciences*. She declares no financial conflicts of interest. Markus Kraemer is chairperson of the German Moyamoya patients' and friends' association and editorial board member of the German-language journal *DG Neurologie*. He received personal fees for educational activities from companies not related to themes of this article (e.g. engaged in multiple sclerosis

and vasculitis). Emmanuel Touzé serves on the editorial board of *Stroke* as assistant editor. He declares no financial conflicts of interest. Ralph Weber, Sonia Alamowitch and Igor Sibon declare no financial or other conflicts of interest. Leonardo Pantoni serves on the editorial boards of *Stroke*, *European Stroke Journal*, *Cerebrovascular Diseases*, *Acta Neurologica Scandinavica*, *Cerebral Circulation – Cognition and Behavior*, and *Neurological Sciences*. He declares no financial conflicts of interest.

References

1. COVID-19 information and resources for JHU. <https://hub.jhu.edu/novel-coronavirus-information> (accessed 21/05/2020)
2. Remuzzi A, Remuzzi G. COVID-19 and Italy: what next? *Lancet* 2020; **395**: 1225–1228.
3. Rosenbaum L. Facing Covid-19 in Italy - ethics, logistics, and therapeutics on the epidemic's front line. *N Engl J Med* 2020; **382**: 1873–1875.
4. Zhao J, Rudd A, Liu R. Challenges and potential solutions of stroke care during the coronavirus disease 2019 (COVID-19) outbreak. *Stroke* 2020; **51**: 1356–1357.
5. Giannis D, Ziogas IA, Gianni P. Coagulation disorders in coronavirus infected patients: COVID-19, SARS-CoV-1, MERS-CoV and lessons from the past. *J Clin Virol* 2020; **9**: 104362.
6. Bickdeli B, Madhavan MV, Jimenez D, et al. COVID-19 and thrombotic or thromboembolic disease: implications for prevention, antithrombotic therapy, and follow-up. *J Am Coll Cardiol* 2020; **75**: 2950–2973.
7. Mao L, Wang M, Chen S, et al. Neurological manifestations of hospitalized patients with COVID-19 in Wuhan, China: a retrospective case series study. *medRxiv*. <https://doi.org/10.1101/2020.02.22.20026500>
8. Aggarwal G, Lippi G, Michael Henry B. Cerebrovascular disease is associated with an increased disease severity in patients with Coronavirus Disease 2019 (COVID-19): a pooled analysis of published literature. *Int J Stroke* 2020; **15**: 385–389.
9. Bersano A, Pantoni L. On being a neurologist in Italy at the time of the COVID-19 outbreak. *Neurology* 2020; **94**: 905–906.
10. Ministero della Salute (Italian Ministry of Health). <http://www.dati.salute.gov.it> (accessed 21/05/2020).
11. La Giunta di Regione Lombardia. <https://www.regione.lombardia.it/wps/wcm/connect/5e0deec4-caca-409c-825b-25f781d8756c/DGR+2906+8+marzo+2020.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-5e0deec4-caca-409c-825b-25f781d8756c-n2.vCsc> (accessed 21/05/2020).
12. Spina S, Marrasso F, Migliari M, Stucchi R, Sforza A, Fumagalli R. The response of Milan's emergency medical system to the COVID-19 outbreak in Italy. *Lancet* 2020; **395**: e49–e50.
13. Baracchini C, Pieroni A, Viaro F, et al. Acute stroke management pathway during Coronavirus-19 pandemic. *Neurol Sci* 2020; **41**: 1003–1005.
14. Caso V, Federico A. No lockdown for neurological diseases during COVID19 pandemic infection. *Neurol Sci* 2020; **41**: 999–1001.

15. Stefanini GG, Azzolini E, Condorelli G. Critical organizational issues for cardiologists in the COVID-19 outbreak: a frontline experience from Milan, Italy. *Circulation* 2020; **141**: 1597–1599.
16. Markus HS, Brainin M. EXPRESS: COVID-19 and stroke - a global World Stroke Organisation perspective. *Int J Stroke* 2020; **15**: 361–364.
17. Italian Stroke Organization. <http://www.iso-stroke.it> (accessed 21/05/2020)
18. Italian Stroke Organization. <https://www.youtube.com/watch?v=znZ5yBYiIYk> (accessed 21/05/2020)
19. Greenhalgh T, Wherton J, Shaw S, Morrison C. Video consultations for covid-19. *BMJ* 2020; **368**: m998.
20. Hollander JE, Carr BG. Virtually perfect? Telemedicine for Covid-19. *N Engl J Med* 2020; **382**: 1679–1681.
21. Bloem BR, Dorsey ER, Okun MS. The coronavirus disease 2019 crisis as catalyst for telemedicine for chronic neurological disorders. *JAMA Neurol* 2020. <https://doi.org/10.1001/jamaneurol.2020.1452>
22. Societe Francaise Neuro-Vasculaire and Societe Francaise Neuroradiologie. https://7e13c1e6-39cc-4444-a56dc67b8fdafed.filesusr.com/ugd/47ae18_e5e804cc2fe24c3da994e543e7618e00.pdf (accessed 21/05/2020)
23. <https://www.societe-francaise-neurovasculaire.fr/single-post/CP-SFNV-SFC> (accessed 21/05/2020)
24. Deutsche-Krankenhaus-Gesellschaft. Corona-Virus: Fakten und Infos. Deutsche KrankenhausGesellschaft. 2020.
25. Deutsche-Interdisziplinäre-Vereinigung-für-Intensiv-und-Notfallmedizin-e.V. Intensivregister - Öffentlich Aktuelle Belegungssituation intensivmedizinischer Bereiche der Krankenhaus-StandorteDeutschlands. 2020. <https://www.intensivregister.de/#/intensivregister> (accessed 21/05/2020)
26. Robert-Koch-Institut. Täglicher Lagebericht des RKI zur Coronavirus-Krankheit-2019 (COVID-19) – AKTUALISIERTER STAND FÜR DEUTSCHLAND Robert-Koch-Institut. 2020. https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/2020-04-07-de.pdf?__blob=publicationFile (accessed 21/05/2020)
27. Deutsche-Gesellschaft-für-Neurologie. Aktuelle Information zur SARS-CoV-2-Pandemie. 2020. <https://www.dgn.org/neuronews/71-neuronews-2020/3894-hinweise-zum-umfang-mit-der-corona-pandemie> (accessed 21/04/2020)
28. Tam CF, Cheung KS, Lam S, *et al.* Impact of coronavirus disease 2019 (COVID-19) outbreak on ST-segment-elevation myocardial infarction care in Hong Kong, China. *Circ Cardiovasc Qual Outcomes* 2020; **13**: e006631.
29. Gori T, Lelieveld J, Münzel T. Perspective: cardiovascular disease and the Covid-19 pandemic. *Basic Res Cardiol* 2020; **115**: 32.
30. 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**: 1891–1895.

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