"Infodemic's" Impact on Patient Behaviour and Stroke Treatment During the COVID-19 Pandemic: An Analysis of Internet Searches and Clinical Data

Marta Nowakowska-Kotas
Department of Neurology, Wroclaw Medical University, Poland
ul. Borowska 213, 50-556 Wrocław
Email adress: marta.nowakowska-kotas@umw.edu.pl
ORCID: https://orcid.org/0000-0002-3173-8337

Krystian Obara
Department of Neurology, Wroclaw Medical University, Poland
ul. Borowska 213, 50-556 Wrocław
Email adress: krystian.obara@umw.edu.pl
ORCID: https://orcid.org/0000-0003-4187-9528

Jakub Stojanowski
Department of Nephrology, Wroclaw Medical University, Poland
ul. Borowska 213, 50-556 Wrocław
Email adress: jakub.stojanowski@student.umw.edu.pl
ORCID: https://orcid.org/0000-0002-0527-2190

Sławomir Budrewicz
Department of Neurology, Wroclaw Medical University, Poland
ul. Borowska 213, 50-556 Wrocław
Email adress: slawomir.budrewicz@umw.edu.pl
ORCID: https://orcid.org/0000-0002-2044-6347

Abstract

Background and Purpose. The COVID-19 pandemic has brought attention to the quality of information the public receives and searches. The rapid and far-reaching spread of both accurate and inaccurate information about COVID-19 has been defined as an "infodemic" by the World Health Organization (WHO). Inaccurate information can lead to delays in seeking medical help, which is particularly concerning for stroke patients who require early intervention.

Aim. The study aimed to analyse the correlation between the incidence of reperfusion therapies at a tertiary stroke centre and active searches by internet users for negative infor-

mation about the condition of the healthcare system and stroke treatment possibilities due to the COVID-19 pandemic

Methods consisted of clinical data of patients who underwent reperfusion therapies in tertiary stroke centre compared to data collected from the Internet using Google Trends™.

Results. The significant decrease in reperfusion therapies conducted during first month of lockdown due to the COVID-19 pandemic has been resolved. It was accompanied by a significant increase in interest in topics related to the poor epidemiological situation in the country. However, significant direct correlations between the active search for information on the Internet and the clinical characteristic of patients were not observed.

Conclusions: The number of stroke patients receiving the best quality treatment significantly decreases, at the same time period when the epidemiological situation creates an active search for negative information on the Internet. This coincidence, arguably, has no direct cause - effect relationship, although it may be presumed accurate and timely information dissemination during a pandemic, particularly for stroke patients who require urgent medical attention, could reduce health-related harm.

Key words: Infodemics, COVID-19, Google Trends, stroke, patients behaviour

Introduction

The quality of information that the public receives and seeks has come under scrutiny due to the COVID-19 pandemic. The World Health Organization (WHO) has coined the term "infodemic" to describe the swift and widespread dissemination of both accurate and inaccurate information about COVID-19. It is worrisome, especially for stroke patients who depend on timely intervention, as inaccurate information can cause delays in seeking medical assistance.

The reperfusion interventions for ischemic stroke patients significantly improve prognosis of those patients who arrive early in the hospital and are capable of receiving such treatment (Goyal et al., 2015; Chen et al., 2015). Patient delay in accessing an emergency stroke centre of longer than 4.5 hours in the case of thrombolysis and 6 hours in the case of mechanical thrombectomy (MT) leads to disqualification for any reperfusion therapy. The awareness of patients and their families of the warning signs and the proper response to them play an important role in early reporting to the stroke unit (Lecouturier et al., 2010),(Rasura et al., 2014) creating so called "chain of life". The importance of various range of public health awareness campaigns, including the use of mass media, urging people not only to recognise the symptoms of the disease but also to react quickly to them is highlighted (Kashif W. Faiz et al., 2019),(Wolters et al., 2015). Regrettably, the successive waves of the SARS-CoV-2 virus, responsible for the COVID-19 pandemic, declared by WHO on 11 March 2020 (Bedford et al., 2020), have had a significant impact on the behaviour of patients seeking pre-hospital care. The widespread fear of contracting the virus, fueled by media reports that public hospitals primarily focus on treating COVID-19 patients, along with daily updates on new infections and fatalities, as well as social isolation and challenges faced by healthcare providers, can diminish individuals' willingness to seek assistance, even when stroke symptoms are correctly iden-

tified, causing delay of arrival time (Dafer et al., 2020)(Goldberg et al., 2021) (Nawabi et al., 2022).

The issue at hand is the quality of information disseminated to the public, as highlighted by the World Health Organization (WHO) and termed as an "infodemic." This concept refers to the rapid and widespread dissemination of both accurate and inaccurate information about a particular subject, such as a disease. A significant challenge arises from the inherent disparity between the pace of scientific advancements, which tend to be slow, and the rapid spread of both the disease itself and the associated information. In a WHO report titled "Managing the COVID-19 Infodemic: Call for Action" (7-8 April 2020), it was observed that identifying individuals seeking information on the internet and social media is more effective than identifying those responsible for originating or sharing misinformation. The questions raised by individuals reflect their demand for reliable information. In the case of stroke, obtaining accurate information promptly is crucial, as reperfusion therapy often requires timely intervention within a limited window of opportunity.

Aim of the study

The study aimed to analyse active searches on the Internet for information about the condition of the healthcare system and stroke treatment possibilities during the first stages of the COVID-19 pandemic and their correlation with the incidence of reperfusion therapies at a local stroke centre.

Materials and methods

We collected Google search engine traffic data using Google Trends™ (Mavragani & Ochoa, 2019) in different time periods: 1) a one-month period one year before the COVID-19 pandemic outbreak (March 15, 2019, to April 15, 2019); 2) the three months leading up to the COVID-19 outbreak (December 15, 2019, to March 15, 2020); 3) a one-month period after the introduction of lockdown in Poland due to the COVID-19 pandemic (March 15, 2020, to the date of school closures, up to April 15, 2020); and 4) the following month (April 16, 2020, to May 15, 2020). These data were limited to the region where the tertiary stroke center was located. Initially, we established the level of interest in the subject based on data collected from March 15, 2019, to April 15, 2019, and compared daily changes in popularity to this baseline. Later, we aggregated daily search traffic into weekly periods. The traffic data focused on topics related to stroke symptoms, nosocomial infections associated with the SARS-CoV-2 virus, and the spread of COVID-19 infection among healthcare professionals. These topics were pre-grouped into collections (see **Table 1**).

Table 1

Terms analysed in search engine traffic data divided in groups related to the epidemiological situation in Poland and symptoms of stroke

Topics related to COVID-19 infection and epidemiological situation in Poland
doctor with coronavirus
infected doctor
coronavirus in hospital
coronavirus in Poland
hospital dedicated to COVID-19 patients
Topics related to stroke symptoms
lack of feeling
amblyopia
aphasia
paresis
stroke
ischaemic stroke
stroke symptoms
brain haemorrhage
dizziness
muscle weakness
imbalance
haemorrhagic stroke

The retrospectively collected clinical data of stroke patients, on whom any of the reperfusion therapies were performed in a tertiary stroke centre with regard to the thrombectomy procedure covering the entire analysed in Google Trends region was divided in periods of time corresponding to the abovementioned: 1) 15 March 2019 – 15 April 2019 when 24h access to TM was not yet implemented, 2) 15 December 2019 – 15 March 2020 when 24 h access to MT was already provided, the mean values were taken into account for future considerations, 3) 15 March 2020 – 15 April 2020 and 4) 16 April 2020 up to 15 May 2020. Data about age, gender, National Institutes of Health Stroke Scale (NIHSS) score, and localisation of the stroke (left/right hemisphere or in the region of posterior circulation) were collected for each patient retrospectively from standard clinical documentation. The basic demographic and clinical data are presented in **Table 2.**

Table 2

Basic demographic data of stroke patients admitted to the hospital over three periods of time

Patients	15.03-15.04-2019 Group 1	15.12.2019-15.03.2020 Group 2	15.03.2020-15.04.2020 Group 3	16.04.2020 – 15.05.2020 Group 4
n	8	97 (average per month 32)	22	34
Age	69.6(SD 12.2)	71 (SD 15.4)	71.9 (SD 12.9)	69.7 (SD 12.9)
Sex	4 males (50%) 4 females (50%)	39 males (40.2%) 58 females (59.8%)	8 males (36.4%) 14 females (63.6%)	17 males (50%) 17 females (50%)
NIHSS	8.13 (SD 3.52)	12.1 (SD 5.6)	12.2 (SD 5.9)	10.5 (SD 5.9)
Left hemisphere	2 (25%)	54 (55.7%)	12 (54.5%)	21 (61.7%)
Right hemisphere	5 (62.5%)	34 (35%)	9 (40.9%)	11 (32.3%)
Infratentorial	1 (12.5%)	9 (9.3%)	1 (4.5%)	2 (5.9%)
Thrombolysis	7	69 (on average 23/month)	14	23
Mechanical thrombectomy	1	63 (on average 21/month; in 34 cases proceeded by thrombolysis)	8 (in 5 cases proceeded by thrombolysis)	19 (in 8 cases proceeded by thrombolysis)

In the next step comparisons of patients from the above periods were performed in order to check whether there were any differences in the populations of patients arriving at the hospital corresponding to the popularity of terms from the groups of stroke-related and COVID-19 infection-related topics.

The design of the study was approved by the Bioethics Commission at Wrocław Medical University.

<div align="center">

STATISTICAL ANALYSIS

</div>

For the clinical data and data collected from the Internet, the measurements were evaluated using the t-test for continuous variables with normal distribution and homogeneity of variances, the Mann–Whitney U test for nonparametric variables, or chi–square statistics for discrete variables. Correlations of the queries related to stroke symptoms and the coronavirus situation in Poland with the clinical characteristic of stroke patients were measured with the Pearson correlation coefficient. $P < 0.05$ was considered statistically significant. Statistical analysis was carried out using STATISTICA v.8 software (Statsoft Inc., USA).

Results

Significant differences were observed in the number of patients admitted to the hospital during the four analysed periods. Following the implementation of 24-hour available mechanical thrombectomy (MT), there was a notable increase in the number of patients receiving reperfusion therapy compared to the previous period (an average of 32 patients per month versus eight patients, $p < 0.001$). However, after the announcement of the lockdown in Poland, a significant decrease in reperfusion therapies was observed (32 versus 22 patients per month, $p < 0.001$). Nevertheless, this still represented a significant increase compared to Group 1 ($p < 0.001$). In the subsequent month (Group 4), the number of reperfusion therapies returned to the pre-lockdown level (34 reperfusion therapies). The primary demographic data, such as age and sex, did not differ significantly between the groups. Although differences in the National Institutes of Health Stroke Scale (NIHSS) scores were observed between Groups 1 and 2 or 3 (8.13 ± 3.52 versus 12.1 ± 5.6 or 12.2 ± 5.9, $p < 0.05$), there were no significant differences in stroke severity between Groups 2 and 3. Additionally, no significant differences were found in stroke localisation (left hemisphere versus right hemisphere versus infratentorial stroke).

Google Trends™ data for all terms related to stroke symptoms showed periodic drops in the popularity of searches that correlated with cyclical events, such as weekends and holidays (Fig.1). The mean value of the interest in those terms in all analysed periods was 67.69%, assuming that the value on Mar 15, 2019, is 100%. Although in the week of 10-16 March 2020, a significant drop in interest (to 41.30%) occurred.
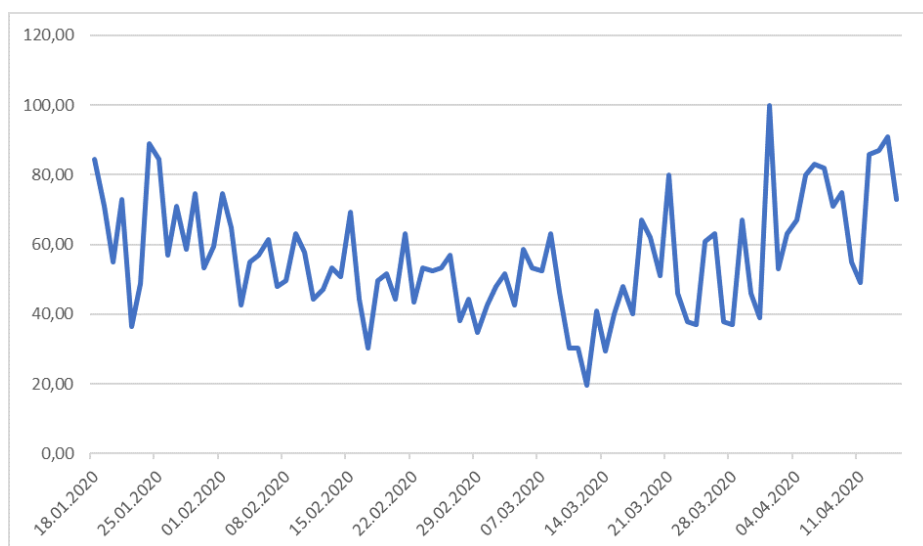

Fig. 1. Cumulative internet traffic for stroke symptoms related terms (most popular day value is 100) in Lower Silesian Voivodeship, Poland. *Source:* own research.

Also, a significant decrease persisted from Mar 8 to Apr 15, 2020, in terms of the popularity of specific topics: paresis, muscle weakness, and aphasia ($p < 0.05$) (Fig. 2). A detailed list of interest in particular terms is presented in Table 3.
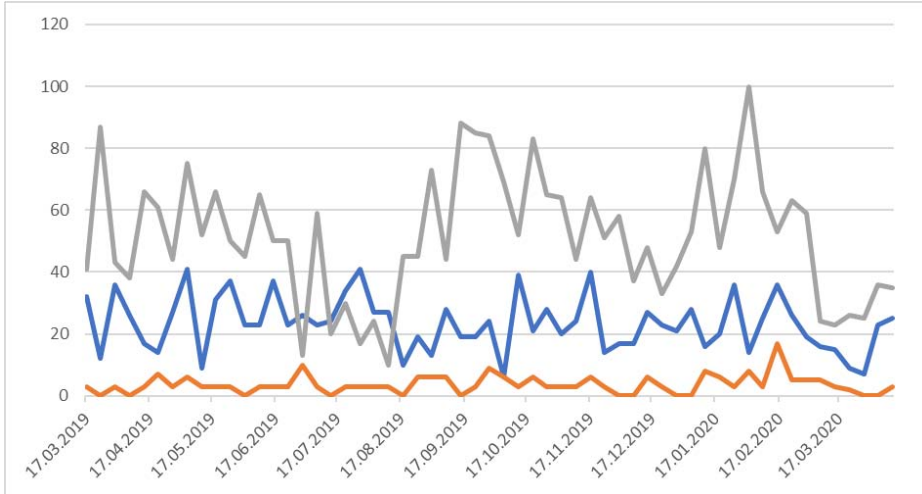

Fig. 2. Internet traffic for specific terms: paresis (blue), muscle weakness (orange), aphasia (grey) in Lower Silesian Voivodeship, Poland; the reference point (100%) for subsequent values is the popularity of searches for aphasia symptoms on 2 February 2020. *Source:* own research.

Table 3
Mean popularity of searched terms Lower Silesian Voivodeship, Poland in analysed periods (15 March 2019 is 100.0%)

Symptoms	15 March 2019 – 15 April 2019	15 December 2019 - 15 March 2020	15 March 2020 – 15 April 2020	p
Stroke	80.41	67.50	73.29	
Dizziness	169.22	175.07	179.09	
Imbalance	87.38	31.55	48.69	
Paresis	26.50	23.94	13.50	<0.05
Muscle weakness	1.50	4.04	1.25	
Aphasia	52.25	53.90	27.50	<0.05

Google Trends™ data indicate an increase in the popularity of inquiries related to Poland's epidemiological situation even before the first COVID-19 case was discovered in Poland (Mar 4, 2020). Later, interest in in-hospital infections and infections among medical staff arose, reaching its peak just three days after the lockdown (Mar 18 2020). After that, a slight decrease in the popularity of COVID-19 infection and epidemiological situation in Poland related topics is observed (Fig.3).
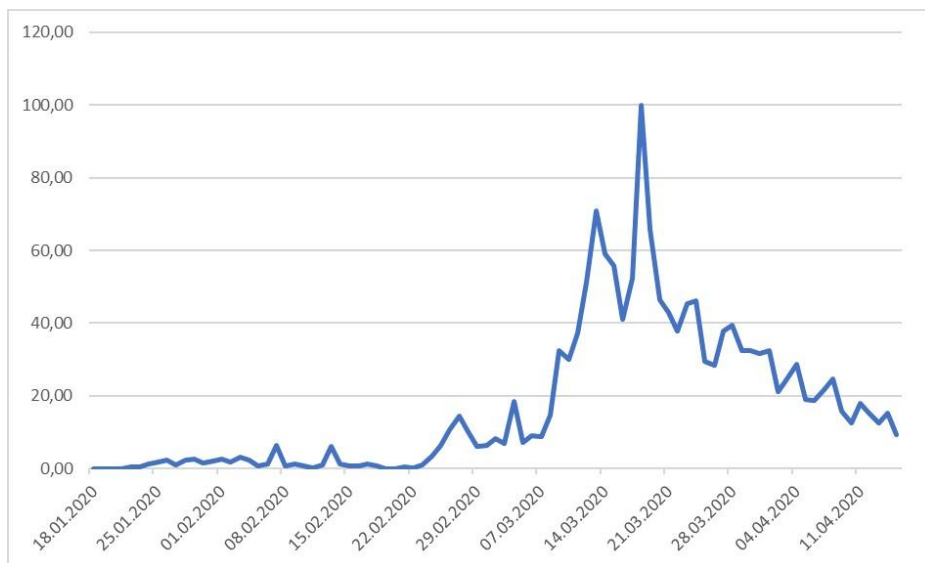
Fig. 3. Cumulative internet traffic for COVID-19-related terms (most popular day value is 100) in Lower Silesian Voivodeship, Poland. *Source:* own research.

The frequency of the inquires for COVID-19 infection-related topics negatively correlated with the popularity of stroke-related searches in the week 3-12 March 2020 (R = -0.883, p< 0.001). With decreasing interest in the coronavirus's epidemiological situation in Poland, the growing popularity of searches for stroke symptoms can be observed in the week of 22 – 29 March 2020 (R = -0.829, p < 0.05). A strong negative and significant correlation was noted between the popularity of the majority of inquires related to the risk of hospital infection and those associated with symptoms of a stroke (Table 4).

Table 4
Pearson correlation coefficients between COVID-19 aware terms and stroke-related terms (both Google Trends^{TM} data) for analyzed periods of time

Terms related to COVID- 19 infection and epidemiological situation in Poland	Terms related to stroke symptoms	R	p
coronavirus in Poland	stroke	-0.951	0.013
coronavirus in Poland	haemorrhagic stroke	-0.942	0.017
doctor with coronavirus	stroke	-0.832	0.081
coronavirus in hospital	aphasia	-0.963	0.037
coronavirus in hospital	paresis	-0.955	0.045
coronavirus in hospital	ischaemic stroke	-0.949	0.051
coronavirus in hospital	haemorrhagic stroke	-0.989	0.001
coronavirus in hospital	stroke	-0.829	0.083
coronavirus in hospital	lack of feeling	-0.897	0.103
infected doctor	haemorrhagic stroke	-0.900	0.037

No significant correlation was found between the frequency of searched terms and patients' clinical characteristics admitted to the hospital in the analysed periods. An example of a correlation of search terms with the severity of stroke measured in NIHSS score is presented in Figure 4.
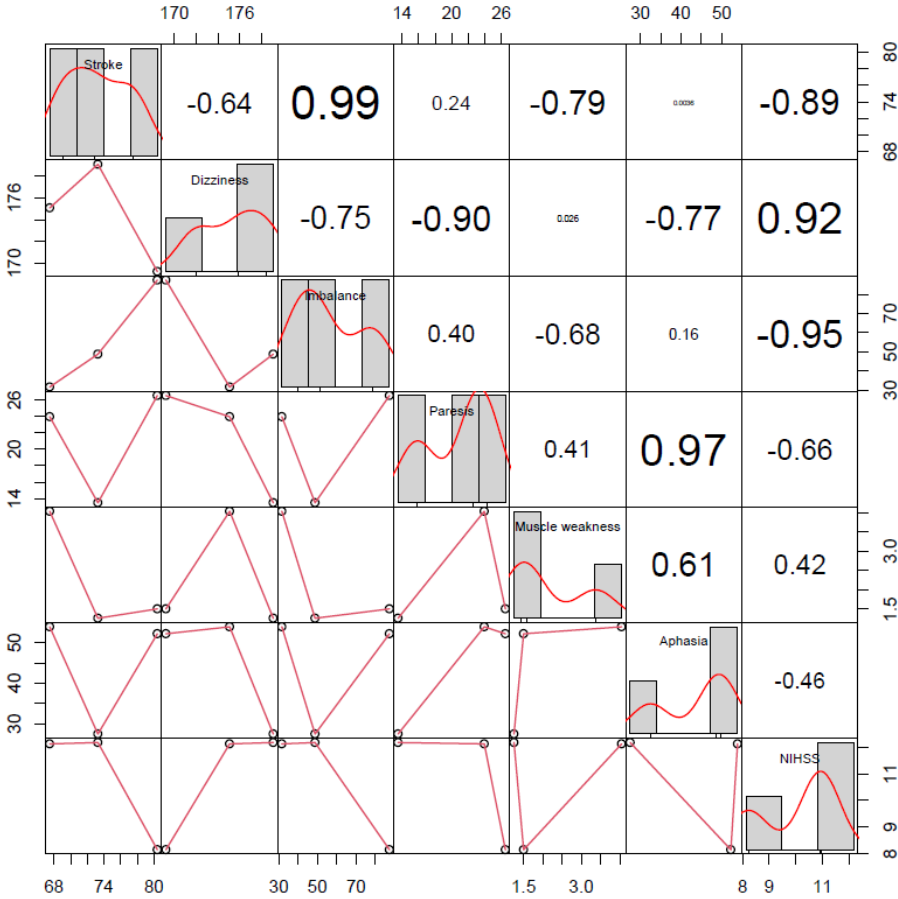

Fig. 4. Correlation of frequency of searches in Google TrendsTM with severity of stroke, measured on NIHSS scale, for patients admitted to the hospital in analysed periods of time. The distribution of each variable is shown on the diagonal. At the bottom of the diagonal, bivariate scatter plots with a fitted line are displayed. At the top of the diagonal is the value of the correlation plus the significance level shown as stars (if applicable). *Source:* own research.

DISCUSSION

The present study confirmed that the epidemiological situation in a country and internet coverage of topics have a substantial influence on the behaviour of stroke patients and their families, although no direct link has been revealed.

An analysis of patient admissions to the stroke centre during the first (pre – pandemic and pre- introduction of 24 h MT time; 15.03-15.04-2019) and second period (pre – pandemic, but after implementation of 24h MT procedure) of the study indicates a notable improvement in the availability of reperfusion treatment in Poland. The improvemet can partially be contributed to public awareness campaigns, although the role of such actons has been repeatedly discussed. Campaigns generally provide good quality informations, raise recognition of stroke symptoms, but they do not always increase the percentage of correct responses to these (Kashif W. Faiz et al., 2019) (Rasura et al., 2014)(Wolters et al., 2015)(Lecouturier et al., 2010). In Poland, previous campaigns from 2009-2012, such as "Stop udarom," "Zapobiegaj Udarowi Mózgu," "Kampania 1na6," and "Masz udar," likely contributed to the number of reperfusion procedures performed in early 2019 (Group 1). Subsequently, a nationwide programme was initiated in mid-2019, introducing 24-hour availability of MT. Shortly after its implementation, there was a significant increase in patients receiving MT and thrombolysis (Group 2), reflecting improved awareness and streamlined procedures.

However, analysing the decrease in the number of acute stroke patients seeking care during the pandemic period compared to previous periods (22 versus 32 patients per month on average, $p < 0.001$), several factors were considered. These included social isolation, difficulties in transportation, and hesitancy among patients to call emergency medical services. We took into account that patients with left hemisphere stroke should be more prone to miss the benefit from an early call for assistance due to aphasia, but we have not found any differences in number of patients with right and left hemisphere stroke. Additionally, Poland's population density and government mandates to stay at home during the pandemic could have influenced patients' ability to seek help. Although, Poland's population density is an average of 2.63 people per flat, meaning that in most households, there are bystanders (GUS, 2019), who had also been persuaded by the government to stay at home. Postponed call of the emergency medical services, on the other hand, has been considered to play an essential role in the pre-hospital delay in studies carried out before the COVID-19 pandemic (Kashif Waqar Faiz et al., 2014)(García Ruiz et al., 2018), and it seems to play main role also in COVID-19 pandemic period(Nawabi et al., 2022)(Goldberg et al., 2021). The last factor taken into account — delaying the decision to call for help – may have a strong connection with Poland's epidemiological situation during this period. This observation would be consistent with the comments from Chicago, where a decline in stroke admissions and emergency calls of 20 percent was noted and those from Italy, where the number of reperfusion therapies (intravenous thrombolysis or combined intravenous thrombolysis and MT) decreased by about 26%-30% during the COVID-19 pandemic (Dafer et al., 2020) (Baracchini et al., 2020). Delays due to extended transport time to hospital are also possible, although it should be mentioned that emergency medical system in the region served by the stroke centre did not experience significant issues during the analysed period from March 15 to April 15.

The COVID-19-related epidemiological situation in Poland has been widely publicised in the media, including on the Internet. On Apr 2, 2020, according to data provided by the Main Sanitary Inspectorate, the number of medical personnel with confirmed COVID-19 amounted to 461 (17% of all cases in Poland) and 4,577 medical staff were in quarantine. On Apr 8, 2020, 30.1% of COVID-19 cases were acquired in hospital environments: staff and patients. In comparison, in Spain (on Apr 6 2020) and in Italy (on Apr 7 2020) medical staff accounted for 14.4% and 10.3 % of all infections in those countries.

The influence of the infodemic on stroke care is evident, as both passive information transfer through various media channels and active internet searches related to COVID-19 have taken place. This heightened interest peaked on March 18, 2020. In this context, it should be noted that, with so much interest in the pandemic issue, active searchers on the Internet have probably lost interest in other topics. At the same time the group of people actively searching for stroke-related issues - was too small to exert effect on Google trends results. It is also reasonable to assume that the group actively searching for information on the Internet (generally young people) and the group of stroke patients (mostly older patients, with an average age in this study of about 70 years) probably do not overlap.

Nevertheless, as a consequence of exposure to substantial negative information, patients have become significantly less inclined to call for an ambulance promptly when experiencing stroke symptoms, which resulted in fewer patients arriving at the hospital without delay. The majority of studies have so far shown that the intended response to stroke does not correlate with sex, marital status, occupation, or existing vascular diseases, but is influenced by knowledge of stroke symptoms and recalled information about stroke from TV or radio (Hickey et al., 2018) (Oh et al., 2019) (Patel et al., 2019). However, in some papers, a significant gap between knowledge about stroke symptoms and risk factors and stroke patients' health behaviour has been established (Kashif W. Faiz et al., 2019) (Fussman et al., 2010).

This study emphasises the crucial importance of high-quality information and the avoidance of spreading misinformation for effective stroke management. The overall strain on the health system during the extraordinary state of the pandemic, combined with the pervasive sense of threat derived from information sources such as the internet, significantly influences people's decision-making processes.

Although there has been a decrease in active searches for stroke-related topics during the pandemic, it is presumed that the population's knowledge regarding stroke symptoms remains unaffected. However, this highlights a widening gap between knowledge and action, indicating that individuals may not be taking appropriate measures despite possessing the necessary knowledge.

Interest in the subject of COVID-19 has changed depending on the current epidemiological situation, regulations introduced by the government and news disseminated in various media. Combined with our clinical observation regarding the admission of stroke patients, we can talk about feedback, when

one sphere affects a specific group of patients. The mainstream news affected all groups and especially those critically affected by delayed response to symptoms. We suggest conducting a balanced narrative, in which there will be no lack of attention to the problems that, despite a pandemic or other disaster, do not disappear from patients' lives. This is especially true for chronically ill patients treated at home or on an outpatient basis, as well as patients who experienced the disease for the first time during the lockdown and paralysis of the health care system. Like other authors (Jarynowski et al, 2020) we observed a certain phasing that was reflected in the admissions of patients to the neurology department for stroke. The popularity of passwords related to symptoms typical of stroke or neurological diseases also changed, pointing to the interdependence between the current situation related to the COVID-19 epidemic and the self-awareness of patients seeking help or information related to their health condition.

This study has some limitations. The study's retrospective design excluded the possibility of conducting interviews or surveys with patients not included in the study because of late arrival at the hospital, thus exluding reperfusion treatment, about the reasons for delaying their call for help. As for the data collected from Google Trends ™, it should be noted that, although the search scope could be narrowed down to a given language and region, the selection of search terms was pre-defined. Thus there is a chance that some other wording would better reflect the mood of internet users regarding stroke and the epidemiological situation related to the pandemic. In addition, one must take into account that group of active users of internet vary from stroke patients probably in several demographic ways, the group of patients and their relativies, who would be capable to search in internet is relatively small in comparison to general population connected to the internet.

Summary

Overall, the findings underscore the importance of ensuring the dissemination of accurate and reliable information to promote prompt and appropriate action in stroke management. Efforts should be made to bridge the gap between knowledge and action, thereby improving stroke outcomes and reducing delays in seeking essential medical help.

Ethical approval: All procedures performed in this study (involving human participants) were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments. As this was a retrospective study, all patients had their consent collected before the standard reperfusion procedures necessary to carry out a typical therapy according to current medical knowledge. Wherever possible (not all patients were conscious due to severe stroke), consent was also collected for the provision of data for scientific research.

References

Baracchini, C., Pieroni, A., Viaro, F., Cianci, V., Cattelan, A. M., Tiberio, I., Munari, M., & Causin, F. (2020). Acute stroke management pathway during Coronavirus-19 pandemic. *Neurological Sciences*. https://doi.org/10.1007/s10072-020-04375-9

Bedford, J., Enria, D., Giesecke, J., Heymann, D. L., Ihekweazu, C., Kobinger, G., Lane, H. C., Memish, Z., Oh, M. don, Sall, A. A., Schuchat, A., Ungchusak, K., & Wieler, L. H. (2020). COVID-19: towards controlling of a pandemic. *The Lancet*, *395*(10229), 1015–1018. https://doi.org/10.1016/S0140-6736(20)30673-5

Chen, C.-J., Ding, D., Starke, R. M., Mehndiratta, P., Crowley, R. W., Liu, K. C., Southerland, A. M., & Worrall, B. B. (2015). Endovascular vs medical management of acute ischemic stroke. *Neurology*, *85*(22), 1980–1990. https://doi.org/10.1212/WNL.0000000000002176

Dafer, R. M., Osteraas, N. D., & Biller, J. (2020). Acute Stroke Care in the Coronavirus Disease 2019 Pandemic. *Journal of Stroke and Cerebrovascular Diseases*, *2019*, 104881. https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.104881

Faiz, Kashif W., Sundseth, A., Thommessen, B., & Rønning, O. M. (2019). The knowing-doing gap in acute stroke—Does stroke knowledge translate into action? *Brain and Behavior*, *9*(3), 1–4. https://doi.org/10.1002/brb3.1245

Faiz, Kashif Waqar, Sundseth, A., Thommessen, B., & Rønning, O. M. (2014). Factors Related to Decision Delay in Acute Stroke. *Journal of Stroke and Cerebrovascular Diseases*, *23*(3), 534–539. https://doi.org/10.1016/j.jstrokecerebrovasdis.2013.05.007

Fussman, C., Rafferty, A. P., Lyon-callo, S., Morgenstern, L. B., & Reeves, M. J. (2010). Lack of Association Between Stroke Symptom Knowledge and Intent to Call 911 A Population-Based Survey. *Stroke,* 1501–1507. https://doi.org/10.1161/STROKEAHA.110.578195

García Ruiz, R., Silva Fernández, J., García Ruiz, R. M., Recio Bermejo, M., Arias Arias, Á., del Saz Saucedo, P., Huertas Arroyo, R., González Manero, A., Santos Pinto, A., Navarro Muñoz, S., Botia Paniagua, E., & Abellán Alemán, J. (2018). Response to Symptoms and Prehospital Delay in Stroke Patients. Is It Time to Reconsider Stroke Awareness Campaigns? *Journal of Stroke and Cerebrovascular Diseases*, *27*(3), 625–632. https://doi.org/10.1016/j.jstrokecerebrovasdis.2017.09.036

Goldberg, S. A., Cash, R. E., Peters, G., Weiner, S. G., Greenough, P. G., & Seethala, R. (2021). The impact of COVID-19 on statewide EMS use for cardiac emergencies and stroke in Massachusetts. *Journal of the American College of Emergency Physicians Open*, *2*(1), e12351. https://doi.org/10.1002/emp2.12351

Goyal, M., Demchuk, A. M., Menon, B. K., Eesa, M., Rempel, J. L., Thornton, J., Roy, D., Jovin, T. G., Willinsky, R. A., Sapkota, B. L., Dowlatshahi, D., Frei, D. F., Kamal, N. R., Montanera, W. J., Poppe, A. Y., Ryckborst, K. J., Silver, F. L., Shuaib, A., Tampieri, D., … Hill, M. D. (2015). Randomized assessment of rapid endovascular treatment of ischemic stroke. *New England Journal of Medicine*, *372*(11), 1019–1030. https://doi.org/10.1056/NEJMoa1414905

Hickey, A., Mellon, L., Williams, D., Shelley, E., & Conroy, R. M. (2018). Does stroke health promotion increase awareness of appropriate behavioural response? Impact of the face, arm, speech and time (FAST) campaign on population knowledge of stroke risk factors, warning signs and emergency response. *European Stroke Journal*, *3*(2), 117–125. https://doi.org/10.1177/2396987317753453

Jarynowski, A., Wójta - Kempa M., Belik, V. (2020). Percepcja Koronawirusa w polskim Internecie do potwierdzenia pierwszego przypadku wirusa w Polsce. [Perception of "coronavirus" on the Polish Internet until arrival of SARS-CoV-2 in Poland] Pielęgniarstwo i Zdrowie Publiczne, *10(2)*, 89–106

Lecouturier, J., Rodgers, H., Murtagh, M. J., White, M., Ford, G. A., & Thomson, R. G. (2010). Systematic review of mass media interventions designed to improve public recognition of stroke symptoms, emergency response and early treatment. *BMC Public Health*, *10*(1), 784. https://doi.org/10.1186/1471-2458-10-784

Mavragani, A., & Ochoa, G. (2019). Google Trends in Infodemiology and Infoveillance: Methodology Framework. *JMIR Public Health and Surveillance*, *5*(2), e13439–e13439. https://doi.org/10.2196/13439

Nawabi, N. L. A., Duey, A. H., Kilgallon, J. L., Jessurun, C., Doucette, J., Mekary, R. A., & Aziz-Sultan, M. A. (2022). Effects of the COVID-19 pandemic on stroke response times: a systematic

review and meta-analysis. *Journal of Neurointerventional Surgery*, *14*(7), 642–649. https://doi.org/10.1136/neurintsurg-2021-018230

Oh, G. J., Lee, K., Kim, K., & Lee, Y. H. (2019). Differences in the awareness of stroke symptoms and emergency response by occupation in the Korean general population. *PLoS ONE, 14*(6), 1–13. https://doi.org/10.1371/journal.pone.0218608

Patel, A., Fang, J., Gillespie, C., & Odom, E. (2019). *Awareness of Stroke Signs and Symptoms and Calling 9-1-1 Among US Adults : National*. 1–9.

Rasura, M., Baldereschi, M., Di Carlo, A., Di Lisi, F., Patella, R., Piccardi, B., Polizzi, B., & Inzitari, D. (2014). Effectiveness of public stroke educational interventions: a review. *European Journal of Neurology, 21*(1), 11–20. https://doi.org/10.1111/ene.12266

Wolters, F. J., Paul, N. L. M., Li, L., & Rothwell, P. M. (2015). Sustained impact of UK FAST-test public education on response to stroke: A population-based time-series study. *International Journal of Stroke*, *10*(7), 1108–1114. https://doi.org/10.1111/ijs.12484