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HOW HAS THE COVID-19 PANDEMIC AFFECTED PATIENTS WITH STROKE? AN EMERGENCY DEPARTMENT PERSPECTIVE

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ABSTRACT

INTRODUCTION: The coronavirus disease 2019 (COVID-19) pandemic has had a profound impact on health-care systems worldwide. The need to manage the pandemic has resulted in significant changes to the way that emergency care is provided. This study aimed to determine whether the COVID-19 pandemic had an impact on the duration between the onset of initial symptoms and admission to the emergency department (ED), as well as the length of stay (LOS) of stroke patients in the ED.

MATERIAL AND METHODS: This was a retrospective analysis of medical records from the ED database. The study involved 566 patients. The following parameters were defined as primary outcomes: length of stay in the ED and time between onset of the symptoms and admission to the ED.

RESULTS: The results of our study showed that during the pandemic patients met the time criteria for thrombolysis therapy (40.72% vs 55.80%, p = 0.00026) and patients spent more time in ED [113 (66–187) vs 85 (35–157) min, p = 0.000026].

CONCLUSIONS: We found a significant increase in the time between onset of first stroke symptoms and admission to the ED and prolonged LOS in ED during the COVID pandemic in comparison to the months before the COVID-19 outbreak.

KEYWORDS: stroke; emergency department; COVID-19; thrombolysis; thrombectomy

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INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in December 2019 in Wuhan, China. Since then it has spread all over the world and contributed to more than 4 million deaths (as of July 2021). The outbreak of the coronavirus disease 2019 (COVID-19) pandemic has changed the functioning of almost every hospital and every individual around the world. According to one of the studies, more than 16% of patients reported delayed

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routine medical check-ups, which was especially significant among patients with chronic diseases [1].

It is worth noticing that providing medical help to patients in life-threatening conditions was continued regardless of the number of COVID-19 patients. However, the changing profile of admissions and the need for increased sanitary rigor has forced a change in the organization of emergency departments (ED) [2]. Early detection and isolation of patients with COVID-19 was crucial to be able to provide appropriate help to patients with other diseases [3, 4]. At the same time, as pandemics spread, many of the medics struggled with burnout, anxiety, depression, or PTSD symptoms and experiences of fear, moral distress, and workplace violence [5–8]. The arrival of the Omicron variant has become an even greater threat to the smooth functioning of the healthcare system and its professionals due to omicron's ability to evade immune control and attack, to some extent, both people already vaccinated and those who had survived COVID-19 [9]. All that led to extremely difficult working conditions and may have affected the quality of patients' care. A good indicator of ED overcrowding is the length of stay [10].

The essential part that appears in almost all of the studies is the time. Stroke is one of the most time-sensitive medical emergencies. In most cases, stroke is easy to diagnose and several different scales may be used [11–13]. Fast response to stroke symptoms and a short period of pre-hospital and in-hospital help decrease not only poor functional outcomes and the number of deaths but also reduces the risk of Secondary Intracerebral hemorrhage [14]. The "Time is brain" strategy significantly improved the time of convalescence and overall outcomes of patients. According to the guidelines, intravenous thrombolysis can be effectively done in patients with acute stroke up to 4.5 h after the onset of the syndromes, and mechanical thrombectomy usually up to 24 h [15]. Of course, we cannot forget about other criteria essential for the correct evaluation of patients, but our focus is on this specific topic. The global impact of COVID-19 on stroke care has been previously described. It was associated with a global decline in the volume of overall stroke hospitalizations, and mechanical thrombectomy procedures [16].

This study aimed to verify whether the COVID-19 pandemic influenced the length of the period between the onset of first symptoms and admission to ED and the length of stay (LOS) of stroke patients in ED.

MATERIAL AND METHODS

Legal issues

According to Polish law, retrospective analysis of medical records does not meet the criteria of medical experimentation and does not require the formal consent of the bioethics committee (Confirmation no. KB — 700/22).

Study design and setting

The study was designed as a retrospective analysis of medical records. Preparation of the manuscript was supported by STROBE Statement — Checklist of items that should be included in reports of cohort studies (Suppl. Tab. 1).

The authors searched the database of the emergency department at Hipolit Cegielski Medical Center in Poznań, Poland. The study group time frame was defined as one year of the COVID-19 pandemic (1 April 2020–30 March 2021). The control group was defined as one year before the study group (1 April 2019–30 March 2020). The object of the research was records coded according to the ICD-10 classification as I63 — Cerebral infarction, unspecified, I64 — Stroke, not specified as hemorrhage or infarction. There were a total of 927 Emergency Department (ED) admissions related to above mentioned codes in the analyzed period. After initial extraction, 361 were excluded due to insufficient data on medical history, age, and symptom classification. As a result, 566 records were qualified for further analysis. The study flowchart was presented in Figure 1.

Outcomes

Primary outcomes were: 1) length of stay (LOS) in the ED defined as the time between first medical contact and final decision; 2) time between onset of the symptoms and admission to the emergency department. The time intervals were defined as follows: less than 4.5 hours (possibility to provide thrombolytic therapy), 4.5 to 24 hours (possibility to provide endovascular treatment), more than 24 hours (thrombolytic treatment and endovascular treatment not recommended), and not possible to estimate.

Statistical analysis

First, the quantitative variables were checked for normality with the use of the Shapiro–Wilk W test. As they did not satisfy normal distribution criteria, they were expressed as the median (interquartile range). The categorical variables were expressed as

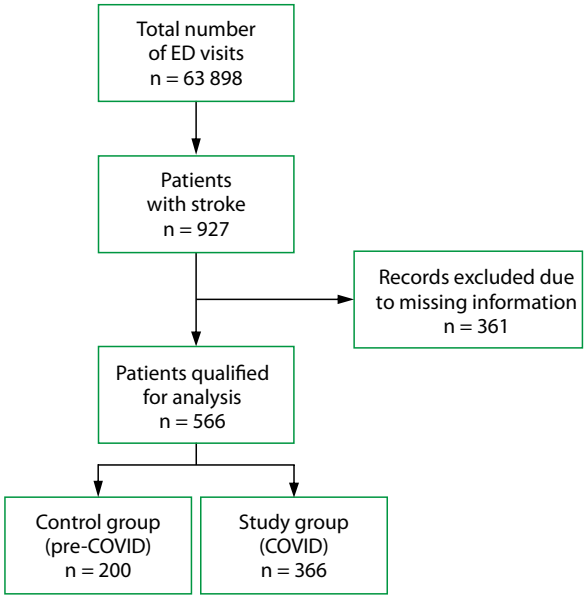

FIGURE 1. The study flowchart

the numbers (n) with percentages (%). For statistical analysis, the Chi-square test and Mann-Whitney test were used as appropriate. A p value less than 0.05 was considered significant. The analysis was performed using the Statistica 12 software (Tibco Inc., Tulsa, OK, USA).

RESULTS

The total number of patients enrolled in the study was 566. Of these, 200 patients (35.33%) were in the pre-COVID period and 366 patients (64.66%) were in the COVID period.

The analyzed group consisted of 50.17% (n = = 284) women and 49.82% (n = 282) men. The median age was 70 (63–80) years old. The youngest patient was 21 years old whereas the oldest was 98 years old. The demographic information of the participants is summarized in Table 1.

Documentation review revealed that the majority of patients had noticed the symptoms within 4.5 hours before medical examination. These individuals represented 44.340% of the study group (n = = 251). In contrast, patients in the time interval group of 4.5–24 h from symptom onset to medical intervention accounted for 30.91% (n = 175), and longer than 24 h represented 15.01% (n = 85) of patients. Individuals with unknown onset of symptoms accounted for 5.65% (n = 31). In the remaining cases (3.88%, n = 22), the time of the analyzed information was not registered in the medical records.

Table 1. The demographic characterization of participants

Variable	Value
LOS [min]	101 (54–180)
Age	70 (63–80)
Male sex	282 (49.82)
Chronic diseases	
Previous stroke	127 (19.87)
Atriaf fibrillation	79 (12.36)
Diabetes mellitus	141 (22.07)
Arterial hypertension	282 (44.13)

LOS — length of stay, *Data were presented as number (%) or median (IQR)

The group of patients who have met the time criteria for thrombolysis did not differ in age compared with the other groups [71 (63–80) vs 70 (62–79) years old, p = 0.6077] and gender (male: 48.61%, n = 122 vs 50.68%, n = 148; p= 0.6289).

Comparison between study and control group

No differences were found between age [70 (64–80) vs 72 (63–81), p = 0.08210] and gender (male: 48.09%, n = 176 vs female: 53.00%, n = 106; p = 0.0263)

Both study groups differed in the proportion of patients admitted at different time intervals of stroke symptoms. More patients in the pre-pandemic group met the time criteria for thrombolytic (p = 0.00026) and endovascular treatment (p = = 0.39513). It was also found that there were no patients with unknown duration of symptoms during this period. Detailed results are presented in Table 2.

There was a statistically significant difference in LOS of patients in the ED depending on the group. During the pandemic, patients stayed longer in the ED regardless of how long their symptoms lasted. However, the statistically significant difference only concerns the period 0–4.5 h and > 24 h. All results from this analysis were summarized in Table 3.

DISCUSSION

One of the most widespread phrases about stroke is "time is the brain". This sentence points to the fact that time is one of the most important criteria for admitting the patient to the correct treatment. We cannot forget about other crucial indicators for our decision such as perfusion imaging and verified contraindications. However, for our research, we

Table 2. Percentage of patients in specific time of symptoms intervals

	COVID		pre-COVID		
Duration of stroke symptoms	[%]	n	[%]	n	p value
0–4.5 h	37.97	139	56.00	112	0.0002
4.5–24 h	30.05	110	32.50	65	0.3951
> 24 h	16.93	62	11.50	23	0.1594
Unknown	8.74	32	0.00	0	N/A

Table 3. Length of stay in emergency department in relation to duration of stroke symptoms*

Duration of stroke symptoms	COVID	non-COVID	p value
Overall	120 (70–203)	98 (48–184)	0.0000
0–4.5 h	76 (44–103)	72 (28–108)	0.3452
4.5–24 h	158 (88–224)	151 (88–202)	0.768659
> 24 h	216 (154–261)	174 (125–246)	0.0003
Unknown	167 (115–264)	No patients	N/A

*Data are presented as median (IQR)

decided to focus mainly on this parameter, mostly due to the clear connection to the work of ED. Research shows that the main factor suggesting better admission time is knowledge about stroke signs and symptoms. Worldwide, this knowledge is still suboptimal but increasing [17–19].

Although the knowledge of the symptoms of stroke and awareness of the need to act quickly when it occurs has been growing steadily in recent years, many patients still arrive at the hospital too late to be treated appropriately. There are many reasons for this: fear, denial, problems with identifying symptoms, and long waiting times for emergency medical services (EMS) [20, 21]. It is confirmed that correct recognition of stroke syndrome is an independent factor associated with early arrival [19].

Many studies have shown that a long stay in the ED was associated with poorer treatment outcomes and higher costs. It can also lead to inappropriate treatment, delayed pain management, and even higher mortality rates. It is also worth noting that emergency departments are generally encumbered with adverse events [22]. Geriatric patients are the most vulnerable in this field. It is commonly known that symptoms in the geriatric population may be atypical. Conditions like delirium or electrolyte disbalance may provoke altered mental status that may be interpreted as a sign of a vascular incident. This group also is at risk of prolonged LOS and requires more ED resources [23]. Other authors also reported increased LOS During the pandemic, EDs were the first line of action and were the most heavily burdened. This must have led to overcrowding, shortages of health workers, and longer stays. Possible reasons for the longer LOS include the requirement to receive a negative test for COVID-19 before admission to a hospital ward. In the initial phase of the pandemic, when PCR tests were not widely available, several hours were awaited for the result. Saban et al. [24] emphasized the crucial role of appropriate organizational practices to strengthen preparedness for extraordinary situations. This supports the need to prepare EDs for thrombolytic therapy in the future if similar conditions were to occur.

The majority of individuals in our study met the criteria for thrombolytic therapy (> 4.5 h) in both COVID and non-COVID groups with the percentages of 40.72% and 55.80%, respectively. This group is larger than in other studies similar to our project. In Indianapolis, only 28.9% of patients were admitted to the hospital within the first 3 hours of onset of symptoms [25]. In Thailand, approximately 38.2% of patients arrived within the first 4.5 hours [17].

COVID-19 has been studied as an independent risk factor for stroke [26]. There are some voices in the scientific community that emphasize the importance of introducing updated preventive cardiology guidelines for this reason [27]. Nevertheless, the data we collected shows that the overall number of patients admitted to the hospital for stroke decreased in the year after the outbreak of the pandemic compared to the year before it began. One potential explanation for the decrease in hospitalizations in stroke could be related to changes in healthcare-seeking behavior [28].

With the start of the pandemic, various restrictions were introduced to social life, which, above all, covered the healthcare sector [29]. Strict lockdown measures had a significant impact on the behavior of patients requiring medical attention for conditions such as stroke. The main factors mentioned as limiting attempts to seek medical help include fear of contracting the virus, overwhelmed healthcare systems, and uncertainty surrounding the safety of hospital environments during the early stages of the pandemic [19]. As a consequence, people who under

normal conditions would decide to come to the hospital more quickly and decisively, delayed calling for help, and more often opted for a wait-and-see strategy, potentially leading to a reduction in hospital admissions.

Another plausible factor to consider is the impact of health promotion campaigns implemented during the pandemic, such as hand hygiene, social distancing, and the use of face masks on the transmission of infectious diseases other than COVID-19. Respiratory infections, such as influenza and pneumonia, are also known risk factors for stroke. By limiting the spread of these infections, the pandemic-related measures might have indirectly contributed to a decrease in the overall incidence of stroke cases during that particular period.

This difference may be also explained by the fact that the availability of ambulances during the pandemic was much worse. Furthermore, staff deficiencies due to staff overload and infections are an important factor [5–8].

It is crucial to emphasize that all of these explanations are speculative and there is a need to conduct comprehensive studies that analyze stroke incidence trends, medical records and patient demographics before, during and after the COVID-19 outbreak to get a better and certain understanding of the underlying factors contributing to the observed decrease in stroke hospitalizations.

After a broad literature search, Banfield et al. [30] claimed that the time between the emergence of a patient requiring immediate medical in the ED and offering them appropriate treatment was not statistically significantly longer during the pandemic, which means that even with many patients suffering from COVID-19, emergency departments were still able to provide efficient and appropriate help to patients with stroke [30].

Limitations

This study has several limitations. First of all, it was a single-center study. It is important to keep in mind that local protocols and practices may influence the investigated parameters such as LOS. We are aware that the results cannot be easily extrapolated to other hospitals. Unfortunately, tPA was not used in our ED and before admission to the stroke unit SARS-CoV-2 test result was required. We did not have access to the specific data regarding contraindications for tPA and outcomes after treatment. Our study primarily focused on assessing the overall impact of the pandemic on stroke patients from an emergency department perspective, including changes in patient characteristics and ED workflow and healthcare utilization. The paper acknowledges that time criteria alone may not fully qualify patients for intravenous thrombolysis and mechanical thrombectomy. This limitation is not explicitly addressed in the study. Additional diagnostic tests, such as perfusion imaging, are required to qualify patients for mechanical thrombectomy between 6–24 hours from stroke onset. Furthermore, the criteria for treatment in the prolonged therapeutic window are only fulfilled by a subset of patients. Some patients may be eligible for both treatment strategies, while others may not be suitable for either treatment due to contraindications. Consequently, grouping patients solely based on admission time intervals may not adequately capture the treatment eligibility and variation among patients. Therefore, the presented paper is intended to provide an ED perspective on which local stroke treatment practice should be imposed.

Further studies should be made to assess a closer correlation between stroke outcomes and the influence of the pandemic. It is advised to gather wider documentation about additional diagnostic tests and qualification to treatment strategies as well as the information from the follow-up, which might indicate a better understanding of the influence of COVID-19.

CONCLUSIONS

Our study revealed a significant increase in the time between the onset of first stroke symptoms and admission to the ED and prolonged LOS in ED during the COVID-19 pandemic in comparison to the months before the COVID-19 outbreak. Emergency departments should be enhanced and encouraged to provide emergency thrombolytic therapy in conditions where it cannot be provided in a stroke department.

Article information and declarations

Data availability statement

Data are available in corresponding author upon reasonable request.

Ethics statement

According to Polish law, a retrospective analysis of medical records does not fulfil the criteria of a medical experiment and the consent of the bioethics committee is not required.

Author contributions

Study design, writing manuscript, data acquisition — W.S., M.W.; concept, study design, writing manuscript — T.K.; writing manuscript, data acquisition — M.T., K.B.; writing manuscript — P.K., critical review, supervision — M.P.

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None.

Conflict of interest

The authors declare that they have no conflict of interest.

Supplementary material

The Supplementary Table 1.

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SUPPLEMENTARY MATERIAL

Supplementary Table 1. STROBE Statement — checklist of items that should be included in reports of cohort studies

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1, 2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	2
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2, 3
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how the study size was arrived at	N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2, 3

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Supplementary Table 1 (cont.). STROBE Statement — checklist of items that should be included in reports of cohort studies

	Item No	Recommendation	Page No
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	2, 3
		(b) Describe any methods used to examine subgroups and interactions	2
		(c) Explain how missing data were addressed	2
		(d) If applicable, explain how loss to follow-up was addressed	N/A
		(e) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study — e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3, Fig. 1
		(b) Give reasons for non-participation at each stage	3, Fig. 1
		(c) Consider use of a flow diagram	Fig.1
Descriptive data	14*	(a) Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders	Tab. 1
		(b) Indicate number of participants with missing data for each variable of interest	Fig.1
		(c) Summarise follow-up time (e.g., average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	3
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done — e.g. analyses of subgroups and interactions, and sensitivity analyses	3, 4
Discussion			
Key results	18	Summarise key results with reference to study objectives	3–5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3–5
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	3–5
Generalisability	21	Discuss the generalisability (external validity) of the study results	3–5
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	6