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Medical emergency team interventions to suspected stroke and stroke mortality during the COVID-19 pandemic in Poland

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ABSTRACT

Introduction: Stroke is a major medical, economic and social problem. It is one of the leading causes of death worldwide in developed and highly developed countries. The most important extra-medical factor in stroke treatment is time. This study aimed to analyse interventions of emergency medical teams (EMT) to suspected stroke cases during the COVID-19 pandemic and determine the mortality rate of the patients in question.

Material and methods: The data come from nationwide IT systems. Data from April 2019 to December 2021 were analysed. A total of 8,801,083 interventions were reported throughout the period. The criterion for inclusion of medical interventions in this study was the diagnosis of stroke (ICD-10: I60–I64) given to patients by an EMT leader. A total of 142,730 interventions met this criterion. Microdata, pseudonymized with a common key, allowed to monitor the patients from the EMT call through hospital admission to death.

Results: In April–December 2020 and April–December 2021 more interventions were reported, compared to the same period in 2019. The number of hospitalizations with a diagnosis of stroke (ICD-10: I60–I64) was significantly lower in the second and fourth quarters of 2020. From the beginning of the pandemic, there was a marked increase in the time taken for EMTs to intervene. Death rates increased during the pandemic period.

Conclusions: There were fewer hospital admissions due to stroke in 2020–2021 compared to the same period in 2019. During the COVID-19 pandemic in Poland, the reported 1-year stroke mortality was significantly higher which might have been caused by multiple reasons including medical, system and socio-behavioural, or combined.

Keywords: COVID-19, emergency medical team, stroke, mortality

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Introduction

Stroke is the leading cause of lifelong, complex disability in adults and one of the most common causes of death [1, 2]. Most events are caused by acute ischaemia of a region of the brain due to occlusion or a critical decrease in flow in a corresponding vessel. Intravenous thrombolysis and/or mechanical thrombectomy are first-class evidence-based medicine causal therapeutic approaches that increase the chance for a favourable outcome even in patients with extensive deficits [3]. The factor massively associated with the outcome for each of these interventions is the time from the symptomatic disease onset to initiation of the intervention (symptoms-to-intervention), or recanalization [4–7]. Taking this fundamental relation, public awareness on when and how to react [8, 9], the capacity of the emergency medical system and thus the pre-hospital phase of care combined with early in-hospital logistics, are among the key factors to decrease the burden of the disease [10].

The temporary reorganization of healthcare systems to minimize COVID-19 (COronaVIrus Disease of 2019) mortality or the related complications, introduced in various ways and degrees in most countries during the pandemic, may have affected the expected outcome for selected other diseases than the infection [11, 12], particularly those where the time "symptoms-to-intervention" association is the greatest. Based on Polish data, it was investigated whether patients with in-hospital diagnosed acute stroke preceded by the emergency medical teams (EMT) intervention were on average later admitted to the hospital during the COVID-19 pandemic than in a pre-pandemic period [13]. The same parameter was analysed for all patients suspected of having a stroke at the emergency medical intervention stage and was additionally examined for any associations with mortality, current SARS-CoV-2 infection, demographic structure, baseline Glasgow Coma Scale (GCS) [14], and the type of a treating centre (hospitals with versus without stroke units).

Material and methods

Data source

The data used was from the Command Support System for National Emergency Medical Services (SWD PRM), the National Health Fund (NFZ) services database, SARS-CoV-2 infections in the Register of Entries to Poland (EWP) system and the registry of deaths kept by the Ministry of Digital Affairs of Poland at the Chancellery of the Prime Minister of Poland (KPRM).

The SWD PRM is a single ICT (Information and Communication Technologies) system in Poland for receiving emergency calls, dispatching EMTs and reporting medical events. The SWD PRM is in operation for all EMTs. Every call made to the emergency ambulance number 999 and calls forwarded by operators of a single emergency number 112 are managed in the SWD PRM. Every departure of an EMT to a medical event is supported and managed by the SWD PRM.

The data collected in the SWD PRM database includes information regarding the location and time of each intervention, including the exact time of the EMT call, departure of the EMT and arrival of EMT at the place of intervention and the transfer of a given patient to the hospital. The database contains information from emergency medical services forms completed by EMT members, including the patient's symptoms, basic vital signs (pulse, blood pressure, oxygen saturation) and GCS scores.

The SWD PRM also reports the type of EMT that intervened. In the Polish system, EMTs are divided into specialist teams, in which there are at least three members authorized to provide emergency medical services. These members include a system doctor, a system nurse or a paramedic and core teams in which there are at least two members authorized to provide emergency medical services, including a system nurse or paramedic.

Statistical analysis

The number of EMT interventions was calculated for each quarter of 2019–2021 (Tab. 1). Then the age-sex structure of a population to whom EMTs were dispatched was presented, together with the identification of types of EMTs (Tab. 1). Moreover, using the GCS, the health status of patients was presented based on emergency medical services forms (Fig. 1). A comparison was made between patients from 2019–2021 in terms of GCS scores using the non-parametric Kruskal-Wallis test and Dunn's posthoc tests with Bonferroni correction. The significance level $p = 0.05$ was adopted.

The median arrival times and intervention times are presented in Table 1 in supplementary materials.

It was analysed whether the patients were eventually transferred to a hospital with a stroke unit, then investigated how many of the calls with suspected strokes ended up in hospitalization, and if the diagnosis made by the EMT was later confirmed in-hospital (Tab. 2).

The final step of the analysis was to evaluate the mortality of the recruited patients based on death registry data [15]. The mortality was shown in four time periods: day of intervention, and post-intervention days 7, 30 and 90.

Data from April 2019 to December 2021 were analysed. A total of 8,801,083 interventions were reported throughout this period irrespective of the reason for the call or the diagnosis [16]. The main criterion to include the medical intervention in the analysis was the initial diagnosis of stroke (ICD-10 codes I60-I64) made by the EMT, and this was met by 142,730 records.

Using the data collected in the EWP database, it was investigated whether patients tested positive for SARS-CoV-2 between 30 days before the EMT intervention

Table 1. The number of stroke interventions by the emergency medical teams (EMT) in each quarter of 2019–2021 based on the Command Support System for National Emergency Medical Services (SWD PRM) database and general characteristics of interventions

	2019	2020		2021	
	Number	Number	Difference by 2019	Number	Difference by 2019
January–March		15,364		16,046	
April–June	15,533	14,961	–3.70%	16,546	6.50%
July–September	15,047	15,714	4.40%	15,682	4.20%
October–December	15,704	16,827	7.20%	16,746	6.60%
	(April-December)	(April-December)		(April-December)	
Number of interventions					
	46,259	47,501		48,970	
EMT type					
P (%)	70.8	73.6		74.8	
S (%)	29.2	26.4		25.2	
City/village size					
< 10 k inhabitants (%)	45.2	45.6		45.1	
≥ 10 k inhabitants (%)	54.8	54.4		54.9	
Age of patients					
Mean	73.3	73.1		73.1	
Median	74	74		74	
Sex					
% of women	51.7	50.4		51	

EMT — emergency medical teams

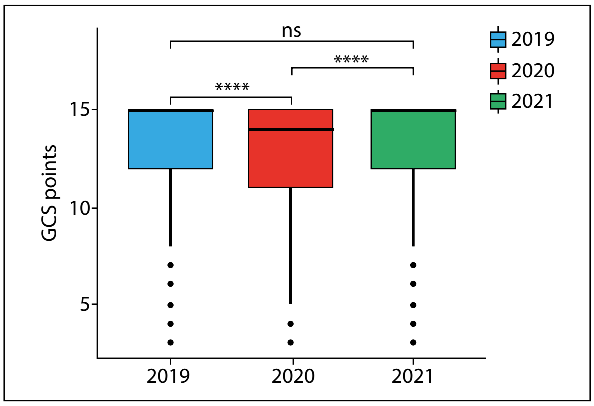


Figure 1. Median Glasgow Coma Scale (GCS) scores in April–December for 2019–2020. The (non-parametric) Kruskal-Wallis test and Dunn's post-hoc tests with Bonferroni correction were used for verifying whether differences in terms of Glasgow Coma Scale scores in particular years were statistically significant; GCS — Glasgow Coma Scale; ns — non-significant difference, **** — p-value < 0.0001

and 1 day following the intervention. The date of the test order was taken into account, considering it to be the best approximation of stroke onset.

Based on the registry of deaths, the mortality rate of patients was calculated for the day of the intervention, within one week, one month, or up to three months after the EMT call. Moreover, using the Kaplan-Meier estimator, survival curves were plotted taking into account variables such as sex [17], age group, GCS score, intervention time and COVID-19 infection. The statistical significance of the differences between survival curves was examined for particular groups using the *log-rank test*. The significance level $p = 0.05$ was adopted.

Results

In April 2020–December 2020 and April 2021––December 2021, 2.6% and 5.8% more interventions related to suspected stroke were reported compared

Table 2. Number of hospitalizations with diagnoses I60–I64 in each quarter of 2019–2021 based on the database of NFZ services

	2019	2020		2021	
	Number	**Number**	**Difference by 2019**	**Number**	**Difference by 2019**
All hospitalizations					
January–March	25,991	26,144	+0.6%	25,346	–2.5%
April–June	26,325	24,556	–6.7%	26,798	+1.8%
July–September	25,940	26,610	+2.6%	25,814	–0.5%
October–December	26,546	24,204	–8.8%		
Hospitalizations with emergency admissions as a result of a transfer by the EMT					
January–March	13,322	14,171	+6.4%	14,506	+8.9%
April–June	13,180	13,781	+4.6%	14,869	+12.8%
July–September	12,704	14,414	+13.5%	13,822	+8.8%
October–December	13,688	14,214	+3.8%		

EMT — emergency medical teams

to the same period in 2019, respectively. The number of interventions by month is shown in Figure 1 (supplementary materials).

The number of hospitalizations with a final diagnosis of stroke (ICD-10 codes I60–I64) was significantly lower in the second and fourth quarters of 2020 (by –6.7 and –8.8%, respectively), while in other quarters of 2020 and 2021, it was similar to the number of hospitalizations in the same periods of 2019. For hospital emergency admissions as a result of a transfer by an EMT, there was an increase in each quarter of 2020 and 2021 compared to 2019 (Tab. 2).

The percentage of interventions provided by specialist teams or core teams in the pre-pandemic period differed slightly from that in the post-pandemic period: there was a decrease in the percentage of interventions provided by specialist teams from 29.2% in 2019 to 26.4% in 2020 and 25.2% in 2021 (Tab. 1).

The pandemic did not significantly change the age–sex structure of the patient group studied.

Out of potential stroke symptoms given as reasons for EMT calls, there was an increased percentage of plegias/pareses and slurred speech (from 59.5% in 2019 to 63.2% in 2020 and 65.2% in 2021). The reasons for EMT calls are documented and categorized by dispatchers based on a conversation with a person reporting a medical incident. The median GCS score for the analysed samples was not significantly different between patients in 2019 and 2021, but in 2020 it was lower (Fig. 1, Tab. 3).

EMT intervention times increased noticeably from the beginning of the pandemic (Fig. 2). In 2019, the median emergency response time for the arrival of an EMT was approximately 9 minutes, whereas the median rescue action time was shorter than 45 minutes. During the initial phase of the pandemic (April–September 2020), EMT arrival time and rescue action time increased by 1 minute and approximately 5–6 minutes, respectively. In October 2020–April 2021, and in October–December 2021, an increase in EMT intervention time was even more pronounced. However, the longest time for EMT arrival and rescue action was observed in December 2021 and it was 13 and 60 minutes, respectively (Tab. 1 — supplementary materials).

The pandemic did not adversely affect the percentage of patients admitted to hospitals with a stroke unit in the structure: approximately 85% were referred to these centres. This percentage even increased in the last quarter of 2021 and reached 87.3–88.5% [18].

The percentage of patients with confirmed SARS-CoV-2 virus during the analysed period correlated with waves of SARS-CoV-2 infection (Fig. 2 — supplementary materials).

In the pre-pandemic period (from April 2019 to February 2020), the percentage of EMT interventions for patients with a stroke resulting in death on the same day was 0.7–1.3%. This percentage increased from October to November 2020 by 1.5–1.8%, then fell back to the previous level in subsequent months, and again increased by 1.5–1.6% in November and December 2021. Similar variations were observed for mortality up to 7, 30 and 90 days. The highest mortality up to 30 days after the EMT intervention was observed in October and November 2020, by 27% and 29% respectively,

Table 3. Symptoms of patients based on emergency medical services forms

GCS scores	2019 (April–December)	2020 (April–December)	2021 (April–December)
Median	15	14	15
15 pts. — %	49	47.1	49.2
14 pts. — %	11	11.1	11.3
13 pts. — %	6.5	6.9	6.8
12 pts. – %	7.1	7.4	7.1
11 pts. — %	6	6.1	5.9
10 pts. — %	5.7	6	5.6
9 pts. — %	4.5	5	4.6
7-8 pts. — %	4.1	4.6	4.4
5-6 pts. — %	1.9	2	1.8
3-4 pts. — %	1.5	1.5	1.4
n.d. (%)	2.6	2.2	2.1
Oxygen saturation			
Median	96	96	97
Mean (SD)	95.2 (5.7)	95.1 (6)	95.4 (5.5)
N.d. (%)	5	3.4	2.4
Systolic blood pressure			
Mean (SD)	154.3 (34)	154.5 (34.1)	155.1 (33.2)
N.d. (%)	1.1	1.2	0.9
Diastolic blood pressure			
Mean (SD)	86.5 (22.2)	86.6 (21.2)	86.7 (21.2)
N.d. (%)	1.4	1.6	1.2
Pulse			
Mean (SD)	86 (20.6)	86.3 (21.7)	86.4 (21.2)
N.d. (%)	2.3	1.8	1.6
Glucose (mg %)			
Mean (SD)	146 (58)	150.5 (61.9)	149.3 (62)
N.d. (%)	7.4	6.9	6.4
Presence of symptoms			
Dyspnoea (%)	2.5	3	2.9
Cyanosis (%)	0.6	0.6	0.5
Apnoea (%)	0.5	0.5	0.4
Paresis (%)	40	38.8	38.8
Aphasia (%)	37.2	37.1	36.9
Syncope (%)	20.2	19.1	18.7
Oedema (%)	3.5	3.9	3.8
Emesis (%)	7.8	7.8	7.7

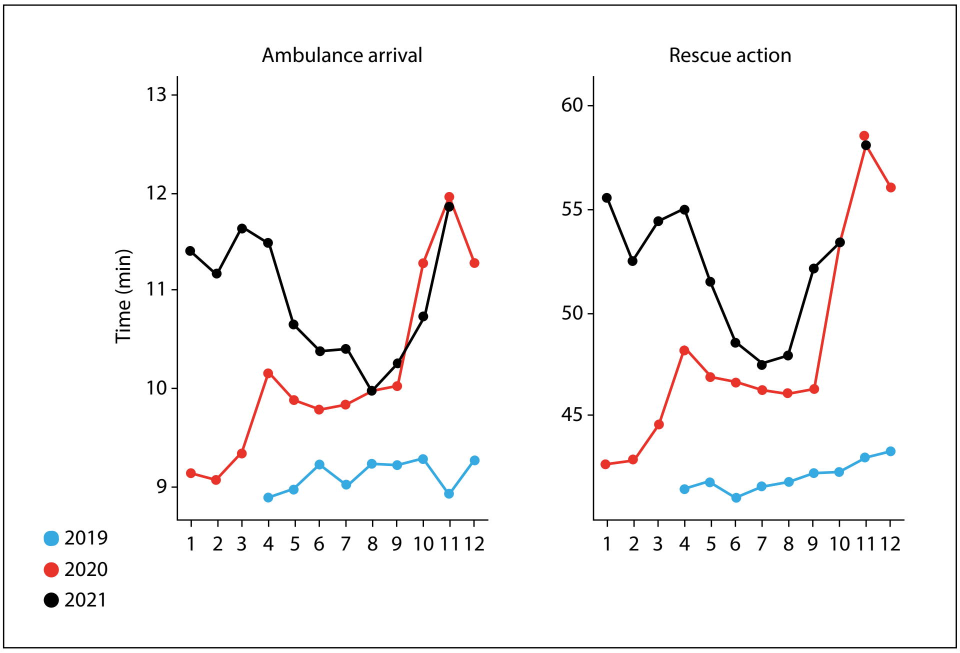


Figure 2. The average time between ambulance call and emergency medical team arrival (left panel) and between emergency medical team arrival and transfer of patient to hospital (right panel) in 2019–2020

compared to 19% in October and November 2019 (Tab. 4, Fig. 3 — supplementary materials).

Survival curves were plotted for patients after the EMT intervention (Fig. 4). Several variables were considered that could potentially explain differences in terms of the probability of survival between various groups and they were also included in databases at the authors' disposal. A strong predictor of patient survival was GCS score ($p < 0.0001$) and age ($p < 0.0001$). Intervention time, SARS-CoV-2 infection status at admission and sex were also significant. SARS-CoV-2 infection was more strongly and negatively correlated with the probability of survival in older age groups. However, the major limitation of this analysis is its non-multivariate structure i.e., that other factors strongly associated with post-stroke mortality were not taken into account because many of them are not available in the databases.

Discussion

During the COVID-19 pandemic, in Poland, as in multiple other countries, there was a decrease in the number of hospitalizations due to acute stroke [19–33]. It was also correspondingly greater in the successive waves of the pandemic (Tab. 2). It is however unlikely that this phenomenon might have been associated with pandemic changes in the EMT system as the number of the interventions that ended up with an in-hospital diagnosis of stroke did not change significantly (Tab. 1). Notably, apart from April and May 2020, i.e. the period that is considered as the earliest of the COVID-19 epidemic in Poland, the number of EMT interventions with suspected stroke was even higher compared to reference months in the previous year, which obviously can be explained by various factors, including the sociopsychological ones. In April–December 2019 and April–December 2020, 94.5% and 93.2% of interventions, respectively, ended up with hospitalization, whereas 60.4% and 63.6% of interventions, respectively, ended up in hospitalization due to stroke (ICD-10 codes I60–I64). In terms of other diagnoses, the most common included G45 – transient cerebral ischaemic attacks (2019 — 7.9%, 2020 — 5.3%), I69 — sequelae of cerebrovascular disease (2019 — 3.9%, 2020 — 3.6%), G40 — epilepsy (2019 — 3.1%, 2020 — 2.3), S06 — intracranial injury (2019 — 1.3%, 2020 — 1.0%), I50 — heart failure (2019 — 1.1%, 2020 — 0.8%). Furthermore, in 2020, 0.9% of hospitalizations following a stroke intervention had a reported diagnosis of U07 — COVID-19.

The percentage of patients with suspected stroke in the emergency services who were further transferred to another hospital unit and either had this diagnosis confirmed or were diagnosed with transient ischaemic attack (TIA), was 68–69%. However, this percentage may still be underestimated due to various reporting

Table 4. The percentage of emergency medical team (EMT) interventions resulting in death between April and December 2019–2021

	Day of intervention			1–7 days after intervention			8–30 days after intervention			31–90 days after intervention			Up to 30 days after intervention			Up to 90 days after intervention		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
April	0.9	1.3	1.2	9.1	11.4	11.5	8.8	9.4	11.1	8.1	8	7.5	18.7	22	23.8	26.9	30	31.4
May	1.2	1.1	1.1	9	10.9	10.1	8.9	9	9.4	7.2	7.5	7.5	19.1	21	20.5	26.3	28.5	28
June	0.9	1.2	1.1	8.6	9.7	9.2	7.4	8.5	9	7.4	8.2	7.8	16.9	19.4	19.3	24.3	27.6	27.1
July	0.7	1.1	1.1	8.7	9.2	8.5	8.7	9.1	8.7	7.4	7.6	7.7	18.1	19.4	18.3	25.6	27	26
August	1	1	1.1	8.2	9.5	8.2	8.1	9.1	8.4	7.5	9.1	9	17.3	19.7	17.7	24.7	28.7	26.7
September	0.9	1.3	1	8.6	10.3	8.8	8.5	9.6	8.6	7.9	11	9.2	18.1	21.2	18.5	25.9	32.2	27.7
October	1.3	1.5	1	8.9	11.5	10.3	8.4	14	10.1	8.5	9.1	8.6	18.6	26.9	21.4	27.1	36.1	30
November	1.1	1.8	1.5	9.6	13.2	10.8	8.7	14	11.5	8.1	8.6	9	19.3	29.1	23.8	27.4	37.7	32.8
December	0.9	1.5	1.6	9.5	11.3	11	9	12.7	11.4	7.9	9.1	5.4	19.3	25.5	24	27.2	34.7	29.3

structural issues, as stroke may not have been the initial diagnosis in some emergency patients. On the other hand, some acute stroke patients may have been initially reported in EMT records with a different diagnosis, such as eg, epileptic seizures (of non-vascular aetiology) or peripheral origin vertigos, but analysing these cases was beyond the scope of this study.

The reported changes in TIA patient numbers during the pandemic might be explained by multiple reasons, also those substantially different to the parallel LVO stroke data, that include the fear of contact with healthcare facilities, which in turn might have augmented the epidemic-related healthcare debt [34].

This analysis revealed that the increase in the interventions in patients with suspected ischaemic stroke that resulted in a fatality coincided with the periods of the greatest waves of SARS-CoV-2 infection (Fig. 3 — supplementary materials). Multiple factors may have resulted in higher post-stroke mortality during the pandemic, and they may be related either to the system being forced to balance care over COVID-19 patients and other diseases in a limited infrastructural and/or clinical issues. They potentially include a longer time to therapeutic and early-prevention interventions or worse access to rehabilitation facilities – among various systemic components, and severe initial neurological impairment or a lower likelihood of a favourable outcome — in patients with coexisting SARS-CoV-2 infection (which — the infection — may also be causal for stroke [35]) among numerous clinical ones. In the analysed cohort, the percentage of deaths in stroke patients with an accompanying active SARS-CoV-2 infection was 36%, and substantially lower in those without SARS-CoV-2 infection (21%). However, given that there are no precise clinical and laboratory data for the studied sample on whether other parameters affecting the outcome were equally distributed in the compared groups, including for example those on initial clinical severity (except the non-specific GCS) and neuroimaging lesion extent, it might be biased to conclude on the effect of SARS-CoV-2 infection on stroke outcome without a proper multivariate analysis.

In the group aged 80+, active SARS-Co-V infection at the time of intervention increased the probability of death within 30 days following the intervention from 31% to 48%, while in the group aged under 60, it augmented the probability of death from 11% to 17% (Fig. 4). Interestingly, SARS-CoV-2–infected individuals had a similar or higher probability of survival compared to uninfected individuals in higher age groups. For example, SARS-CoV-2-infected individuals aged 60–69 have a survival rate of 29% within 30 days following the

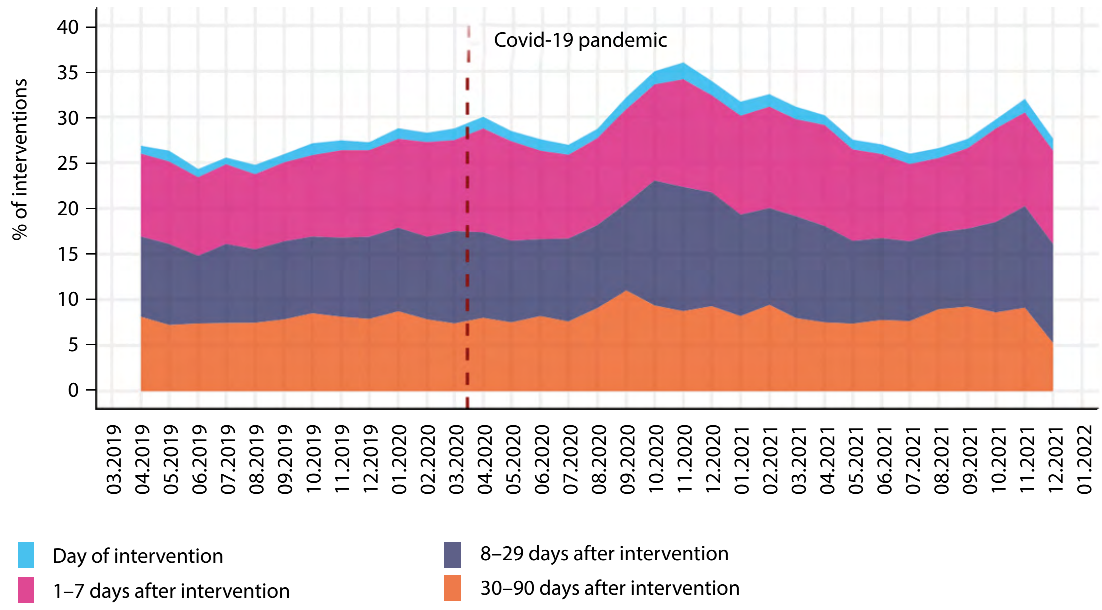


Figure 3. The percentage of interventions resulting in death from April 2019 to December 2021 according to the time elapsed from the intervention to the death. Patients who tested positive for SARS-CoV-2 virus from 30 days before the intervention to 1 day after the intervention were excluded from the analysis

intervention, whereas in uninfected individuals aged 70–79, it was 19%. Importantly, the increase in mortality rates of patients hospitalized due to stroke during the pandemic remained visible even after excluding those with confirmed COVID-19 (Fig. 3). Some of these excess deaths might have been related to undiagnosed COVID-19 cases (more likely especially in the first months of the pandemic), but some may have been also secondary to sociopsychological (behavioural) issues and health care system changes during peak infection waves to cover both the pandemic and routine care [36]. One of the most obvious reasons associated with the latter might have been an increase in the EMT response time, while in the acute phase of stroke, the time from onset to intervention is therapeutically crucial, and thus it is not surprising that in the analysed sample, the increased intervention time coincided with increased mortality rates (Fig. 2) and with epidemic waves (peaks) of COVID-19. However, another prominent reason for the SARS-CoV-2 unrelated increase in stroke mortality in the investigated pandemic space might have been the worse condition (GCS) of patients at the time of the intervention, observed in 2020 but not in 2021 (Tab. 3), caused for example due to delays in calling the EMT in a specific socio-psychological epidemic background (longer stroke onset — call times).

Key results: Fewer hospital admissions due to stroke and only a slightly higher number of emergency interventions for suspected stroke during the pandemic.

Higher mortality among patients with suspected stroke who were admitted to hospitals following the EMT interventions.

Worse initial condition of patients with suspected ischaemic stroke in 2021 when considering the GCS, as compared with 2020.

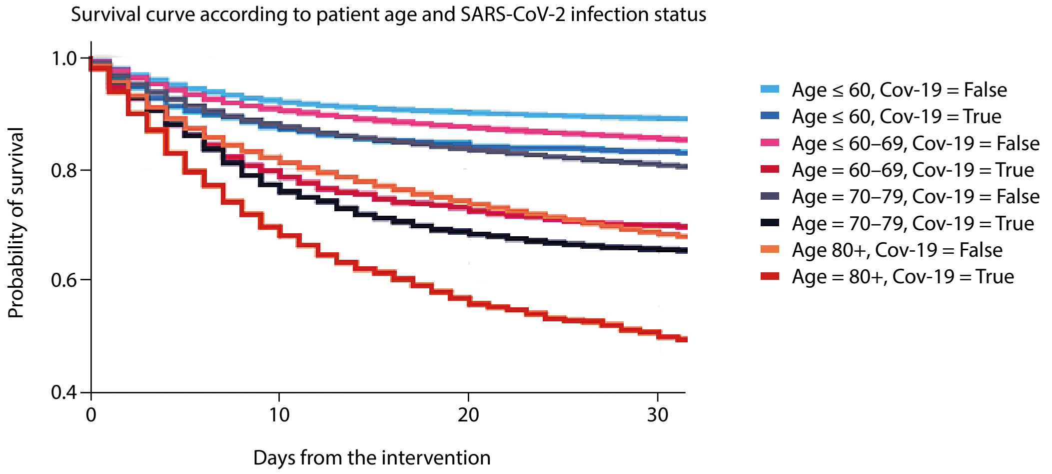
Longer intervention times in 2021 as compared with the same months in 2020.

SARS-CoV-2 infection affects mortality rates in a simple analysis (the proper multivariate analysis is not available due to lack of data).

Similar percentages of acute stroke patients treated at stroke units throughout the analysed periods.

Limitations

Due to a change in the ICT (EMTs reporting) system, the authors had access to data on ambulance calls from April 2019 only, hence, the analysis did not cover a full year. Moreover, at the time of analysis, the information regarding hospital treatment for the last quarter of 2021 was not yet available. The analysed source database at the authors' disposal did not cover multiple



Number at risk

Time	0	10	20	30
Age ≤ 60, Cov-19 = False	15,113	13,937	13,620	13,461
Age ≤ 60, Cov-19 = True	498	437	423	415
Age ≤ 60–69, Cov-19 = False	29,441	26,725	25,783	25,198
Age = 60–69, Cov-19 = True	1118	895	823	789
Age = 70–79, Cov-19 = False	35,052	30,882	29,346	28,380
Age = 70–79, Cov-19 = True	1558	1210	1085	1035
Age 80+, Cov-19 = False	43,006	35,284	31,979	29,646
Age = 80+, Cov-19 = True	1763	1235	1017	908

Percentage at risk

Time	0	10	20	30
Age ≤ 60, Cov-19 = False	100	92	90	89
Age ≤ 60, Cov-19 = True	100	88	85	83
Age ≤ 60–69, Cov-19 = False	100	91	88	86
Age = 60–69, Cov-19 = True	100	80	74	71
Age = 70–79, Cov-19 = False	100	88	84	81
Age = 70–79, Cov-19 = True	100	78	70	66
Age 80+, Cov-19 = False	100	82	74	69
Age = 80+, Cov-19 = True	100	70	58	52

Figure 4. Survival curve of patients from stroke interventions according to age group and SARS-CoV-2 infection status

data necessary to properly consider stroke aetiologies or risk and outcome-associated factors.

Article information

Data availability statement: *The data that support the findings of this study are openly available at https://analizy.mz.gov.pl/html/rm_udary/index.html*
Ethics statement: *This study was conducted as a retrospective analysis of administrative health claims. Patient consent was waived due to the fact that data were obtained and analysed only anonymously.*
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