Management of possible stroke by laypeople in pre-hospital setting: Who should we train?

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Abstract. *Background and aim:* The pre-hospital management of a possible stroke is fundamental for the transport of patients to the correct HUB facility; thus, they must be transported to the Emergency Department (ED) by EMS vehicles. Our study aims to analyze the factors correlated with a higher probability of accessing the ED through the EMS in this event. *Methods:* This is a retrospective observational study. All accesses in the 120 EDs of the Lombardy region, with a diagnosis of discharge whose symptoms could resemble CPSS, were analyzed between 1 January 2019 and 31 December 2019. *Results:* We identified an increased probability of using the EMS vehicles of 0,05% (I.C. 95%: 0.04% - 0.06%; p<0.0001) for each additional year of age, considering patients aged 20 to 100 years and the percentage was significantly higher in the female population (58% vs 49%; p<0.001). Moreover, we calculated that the incidence of stroke was approximately 140 cases per 100,000 inhabitants. *Conclusions:* Only half of the citizens in the Lombardy region use the EMS in case of suspicion of stroke; further information campaigns are essential to educate citizens. Information strategies should be directed especially at men between 30 and 59 years old. (www.actabiomedica.it)

Key words: emergency care pre-hospital, emergency medical services, Italy, stroke, training

Background

During the Covid-19 pandemic (1) the EMS (Emergency Medical System) and hospitals (2–5) have undergone significant changes in their organizational structure and in patients' management (6,7). The time-dependent stroke network also underwent this major reorganization (8,9).

In the pre-hospital setting, only a clinical finding can lead to the suspicion of a stroke (10); in fact, the diagnosis of certainty is possible only after accessing the ED (Emergency Department) with second-level diagnostic tests. Nonetheless, it is important to recognize a possible stroke right from the call to the EMS, because the centralization time to the hospital, meaning the transport of the patient to the correct HUB facility, and the early warning to the admission hospital are essential to improve the outcome (11,12). Different scales have been developed to increase stroke recognition (13,14), to speed up the possible diagnosis by the EMS, which can then activate specific protocols in a short interval of time(15,16).

Patients' management by the EMS improves the outcome (12,17) and guarantees treatment within the necessary time (18,19). For this reason, the laymen, who either face the symptoms of a possible stroke or of another time-dependent pathology as patients or witness them as bystanders, must activate the EMS and must not use their own means for accessing the ED independently. To improve the management of a

possible stroke, the EMS has activated different projects (21,22) and they also studied the position of the hospitals, to ensure travel times are in line with the indications (23).

Nonetheless, the chain of survival must begin with the call to 118, the number of the Emergency Urgency Health Service (Servizio Sanitario Emergenza Urgenza), from either patients or bystanders (24), but adherence to this indication does not reach satisfactory values (25), despite the numerous information campaigns (26) that have shown a partial result in increasing adherence to call 118 (27).

The barriers that prevent the access of patients to the 118 system are many and varied (28); in fact, factors such as sex, age, or the presence of cohabitants (29) can influence the choice to call 118. For this reason, the formation of laymen is an important issue and must be implemented for the recognition of a possible stroke (30, 31).

Lombardy is the most populated Italian region with about ten million inhabitants; the whole Emergency Urgency system is managed by a single Agency, AREU (Agenzia Regionale Emergenza Urgenza – Emergency Urgency Regional Agency). Each call to the 118 system is handled by a professional operator present in the operations center, who, based on the type of patient and his characteristics, defines the vehicle to be sent to the scene. Vehicles are divided into basic life-support medical vehicles (BMV) with crews trained in Basic Life Support (BLS) maneuvers, Intermediate Life Support (ILS) medical vehicles with nurses (IMV), and Advanced Life Support (ALS) medical vehicles with both doctors and nurses; all IMV and AMV crews are trained in ALS (32).

Based on the clinical feedback of the patient at the scene, evaluated by either the doctor or the nurse according to the vehicle sent, the central office defines the hospital of destination. For AREU doctors and nurses, a possible stroke is defined as a patient with a positive Cincinnati Prehospital Stroke Scale (CPSS) (17), and the patient is centralized in one of the 38 regional HUB structures.

All patients who access an ED in the Lombardy region are registered in a single portal, called EUOL (Emergency and Urgency Online). Within the portal, 120 EDs of the region are present and both walk-in patients and those who access through the 118 system are registered (2).

Our study aims to define the factors correlated with a higher probability of accessing the ED through the 118 system in the event of a possible stroke.

Methods

This is a retrospective observational study. The study was conducted in accordance with the principles of the Helsinki Declaration.

All accesses in the 120 EDs of the Lombardy region which presented a diagnosis at discharge whose symptoms could resemble CPSS were analyzed in the period between 1 January 2019 and 31 December 2019.

We considered the ICD9 CM code for stroke (430.X, 431.X, 432.X, 433.X, 434.X, 435.X, 436.X, 437.X, 443.X).

The categorical variables are presented as absolute values and percentages, while the continuous variables are presented as mean and standard deviation. The categorical variables were analyzed using the χ^2 test, and a linear regression has been implemented to correlate the age of the groups and the possibility to access the ED using the 118 system.

Differences were considered significant when $p < 0.05$, otherwise they were considered non-significant (NS). The CI was defined at 95%. The Prism 8.0.1 statistical software (GraphPad Software LLC, San Diego, CA, USA) was used for this aim.

Results

In 2019, 25113 diagnoses of stroke-like syndromes were registered in Lombardy, according to the EDs portals; of these, 13436 (53%) had access with transport performed by the 118 system, while 11677 (47%) were walk-in patients. The mean age of the patients was 74 (15) and 12722 (51%) were females. 5598 (22%) patients have been registered as red codes, while 13466 (54%) as yellow.

221 (129 F and 92 M) died in the ED, of which 92% (203) were over 70 years old. Of these, 73% (161)
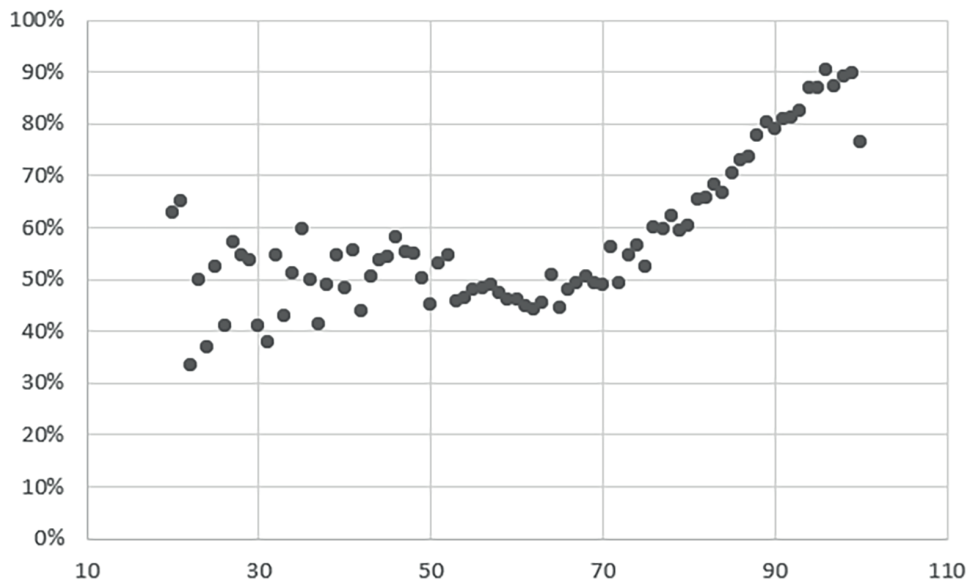
Figure 1. Percentage of patients (y-axis) with possible stroke admitted to the ED transported by the 118 system, grouped by age (x-axis).

had intracerebral hemorrhage (ICD 9-CM: 431) as a discharge diagnosis, and 8% (18) had subarachnoid hemorrhage (ICD 9-CM: 430).

In Figure 1, we performed a linear regression between the age of the subjects and the percentage of subjects who accessed the ED via the 118 system. We identified a coefficient equal to Y= 0.005*X+0,175, with a 95% CI range of 0.004 a 0.006; p<0.0001, meaning that there is an increased probability of using EMS vehicles of 0,05% for each additional year of age. The analysis was carried out taking into consideration patients aged 20 to 100 years.

The number of females with a diagnosis was 12730 (51%) and 7357 (58%) of them were transported by the EMS; 6079 (42%) were walk-in patients. The number of men was 12383 (49%) and 6079 (49%) of them were transported by the EMS; 6304 (51%) were walk-in patients.

The percentage of patients transported by the 118 system was significantly high in the female population (58% vs 49%).

In Table 1, we calculated the incidence of stroke-like syndromes per 100,000 inhabitants per year divided by age group. The demographic data was calculated taking into consideration the ISTAT (Istituto

Table 1. Distribution of patients by age group and incidence of stroke-like syndromes per 100,000 inhabitants per year.

	Men	**Females**	**Total**
0-9	2,9	6,6	4,7
10-19	10,7	9,1	10,0
20-29	20,9	23,5	22,2
30-39	31,9	35,3	33,6
40-49	49,5	75,7	62,4
50-59	114,4	178,1	146,3
60-69	254,4	374,0	316,5
70-79	647,6	632,8	639,6
80-89	2035,8	962,5	1377,2
90 +	6689,1	802,5	2228,5
Total±	258,8	241,6	250,0

±19 patients missing, missing data on sex

Nazionale di Statistica – National Statistical Institute) 2019 population data, using the reference population of 2019. The incidence was calculated by including the diagnosis of stroke (ischemic and hemorrhagic – about 14000), transient total amnesia (1922), and transient acute ischemia (7346); the diagnosis codes are shown in the Supplementary materials (Table S1).

Using the data in the Supplementary materials, we can define that the incidence of stroke in the Lombardy region is approximately 140 cases per 100,000 inhabitants per year.

In Table 2 we divided walk-in patients and patients transported by 118 vehicles stratified according to the triage code at arrival to the ED, whereas in Table 3 we distributed the two categories of patients according to the outcome.

Out of 489 subjects who either abandoned the ED or refused hospitalization, 137 (28%) have a diagnosis of unspecified transient cerebral ischemia (ICD9 4359), 78 (16%) have a diagnosis of other specified transient cerebral ischemias (ICD9 4358), 45 (9%) have a diagnosis of intracerebral hemorrhage (ICD9 431) and 43 (9%) cerebral thrombosis with cerebral infarction (ICD9 43401).

In addition, Table 3 underlines that 217 patients died after entering the ED. Of these, 206 accessed the EDs using EMS vehicles, and 11 self-presented.

Patients that have been hospitalized after accessing the ED on their own amount to 24.6% of the total of cases taken into consideration.

Discussion

Following the purpose of the study, we highlighted the demographic factors that characterize the population that uses the 118 system in case of stroke-like symptoms. We report that only 53% of patients with stroke or stroke-like syndromes access the ED by transport with the 118 system; among the factors considered, the age of the subject is positively correlated with the use of the EMS. In fact, the percentage of subjects that use this system increases by about 0.5% for each additional year of age. This phenomenon could be linked to the greater fragility of elderly subjects, who often have more comorbidities and for which a lower degree of autonomy could explain the use of the EMS. Furthermore, stroke is perceived as a rare pathology in young subjects, who may therefore not think of a stroke and go to the ED by their own means, thinking about a different cause of the symptoms.

The link between the symptoms under study and the age of the patient is highlighted in Table 1, which shows the incidence per 100,000 inhabitants of stroke-like pathologies in the Lombardy region. The incidence increases markedly beyond the 50-59 range. The total incidence is equal to 250.00 cases per 100,000 inhabitants, with a greater impact on the men population than on the female population (258.8 vs 241.6).

Regarding Table 1, it is important to point out that the incidence in the subjects aged over 90 years in the men population has little relevance because the resident population is small and is less than a third of the female population.

In our analysis, we found that the female population is more predisposed to use the 118 system than the men population (58% vs 49%, p <0.001). The reason could be linked to greater sensitivity during an emergency.

Table 2. Triage code and arrival mode.

Triage	118 vehicle	Walk-in patients
White	31 (0.2%)	85 (0.9%)
Green	2094 (15.4%)	3159 (32.8%)
Yellow	7044 (51.8%)	5552 (57.6%)
Red	4427 (32.6%)	848 (8.8%)
Black	1 (0,01%)	0
Not performed	11 (0.08%)	75 (0.80%)
Total$^\pm$	13608 (58.4%)	9719 (41.6%)

$^\pm$1786 data are missing; χ2 test p-value < 0.001

Table 3. Arrival mode and outcome.

Arrival mode	Deceased	Discharged	Abandoned the ED	Hospitalized
118 vehicle	206 (0.9%)	2633 (11.3%)	154 (0.7%)	10615(45.5%)
Walk-in patients	11 (0.1%)	3636 (15.6%)	335 (1.4%)	5737 (24.6%)
Total$^\pm$	217	6269	489	16352

$^\pm$1786 data are missing; χ2 test p-value < 0.001

We recorded a significant difference between the triage code at arrival in the ED and transport mode. In fact, in case of patients with a red access code, 32.6% accessed the ED via EMS while 8.8% with their own vehicle. This trend is reversed in green code patients, where only 15.4% accessed the ED on a 118 vehicle compared to 32.8% who self-presented. Greater use of the 118 system in case of clinical instability or higher triage code is foreseeable; in fact, an autonomous transport may not be practicable, though the number of subjects in red code transported autonomously remains very high; these patients are exposed to an important risk. In fact, they could go into shock during the transfer and not be attended to by properly trained staff.

As presented in Table 3, there are also significant differences regarding the outcome; in fact, the percentage of patients admitted after access to the emergency room is equal to 45.51% in subjects who have access employing the 118 system and 24.59% in subjects who have autonomous access. It is very relevant to report that 489 subjects leave the ED before having a destination or before the diagnostic-therapeutic workup is completed. Furthermore, we point out that the number of deaths is higher in the population transported by EMS (0.9% vs 0.1%); this shows how the 118 system is used only in cases where the patient has greater instability.

The management of a possible stroke must begin as soon as possible, from the moment that either the patient or a bystander recognizes symptoms that hint at it. The transportation of these patients to the correct HUB facility is essential to correctly identify and diagnose the stroke with specific tests and treat the patients according to the protocols to improve their outcomes. Thus, the management of the possible stroke begins on the scene of the onset of symptoms and the EMS must be alerted.

The barriers preventing the access of patients to the EMS are known to be mainly sex, age, and the presence of cohabitants.

This study analyzed the behavior of the population of the Lombardy region when facing or witnessing the symptoms of a possible stroke, to identify specific sub-populations that are less likely to alert the EMS in case of a possible stroke. This will help design specific informative campaigns targeted specifically to those sub-populations so that more and more citizens will be aware of the importance of the use of the EMS. Moreover, we calculated the incidence of stroke-like syndromes and stroke in the Lombardy population.

Our study has some limitations; in fact, a series of clinical diagnoses made in the ED that are attributable to stroke are examined, such as amnesia, TIA (Unspecified Transient Cerebral Ischemia) and stroke, but we must point out that other conditions, such as facial paralysis, can give a similar picture but have not been examined within our population. Furthermore, following the pandemic, the habits of the population might have changed, and patients might therefore make greater use of the 118 system. A reason that could explain why few patients use the EMS might be the proximity of residential areas to large hubs, and for this reason, they might access the ED autonomously within short intervals of time; it becomes difficult to act on this population also because they see a great opportunity in autonomous access to the ED.

Conclusion

Our study shows that only half of the citizens use the 118 system, thus for this reason it is necessary to implement further information campaigns. Information strategies should be aimed at men subjects aged between 30 and 59, to identify and train the most refractory population.

A further study might have the purpose of defining only the patients diagnosed with stroke to understand if indeed in the case of the specific pathology, the attitudes and behavior of the subjects remain unchanged.

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Appendix – Supplementary files

Table S1.

ICD 9 CM	CODING	F	M	Tot
4359	UNSPECIFIED TRANSIENT CEREBRAL ISCHEMIA	2379	2189	4568
431	INTRACEREBRAL HEMORRHAGE	1983	2126	4109
4358	OTHER SPECIFIED TRANSIENT CEREBRAL ISCHEMIAS	1437	1341	2778
43401	CEREBRAL THROMBOSIS WITH CEREBRAL INFARCTION	990	970	1960
4377	TRANSIENT GLOBAL AMNESIA	1027	895	1922
4371	OTHER GENERALIZED ISCHEMIC CEREBROVASCULAR DISEASE	898	837	1735
43400	CEREBRAL THROMBOSIS WITHOUT MENTION OF CEREBRAL INFARCTION	764	749	1513
436	ACUTE, BUT ILL-DEFINED, CEREBROVASCULAR DISEASE	707	653	1360
43491	CEREBRAL ARTERY OCCLUSION, UNSPECIFIED WITH CEREBRAL INFARCTION	502	500	1002
4321	SUBDURAL HEMORRHAGE	282	472	754
430	SUBARACHNOID HEMORRHAGE	348	289	637
43490	CEREBRAL ARTERY OCCLUSION, UNSPECIFIED WITHOUT MENTION OF CEREBRAL INFARCTION	244	240	484
4379	UNSPECIFIED CEREBROVASCULAR DISEASE	185	170	355
43411	CEREBRAL EMBOLISM WITH CEREBRAL INFARCTION	200	153	353
4378	OTHER ILL-DEFINED CEREBROVASCULAR DISEASE	173	171	344
43410	CEREBRAL EMBOLISM WITHOUT MENTION OF CEREBRAL INFARCTION	158	142	300
4370	CEREBRAL ATHEROSCLEROSIS	92	104	196
4329	UNSPECIFIED INTRACRANIAL HEMORRHAGE	84	104	188
43310	OCCLUSION AND STENOSIS OF CAROTID ARTERY WITHOUT MENTION OF CEREBRAL INFARCTION	41	67	108
4430	RAYNAUD'S SYNDROME	48	21	69
4373	CEREBRAL ANEURYSM, NONRUPTURED	33	28	61
4350	BASILAR ARTERY SYNDROME	30	20	50
43311	OCCLUSION AND STENOSIS OF CAROTID ARTERY WITH CEREBRAL INFARCTION	14	23	37
4372	HYPERTENSIVE ENCEPHALOPATHY	16	16	32
43301	OCCLUSION AND STENOSIS OF BASILAR ARTERY WITH CEREBRAL INFARCTION	11	13	24
43320	OCCLUSION AND STENOSIS OF VERTEBRAL ARTERY WITHOUT MENTION OF CEREBRAL INFARCTION	8	13	21
43390	OCCLUSION AND STENOSIS OF UNSPECIFIED PRECEREBRAL ARTERY WITHOUT MENTION OF CEREBRAL INFARCTION	9	9	18
43300	OCCLUSION AND STENOSIS OF BASILAR ARTERY WITHOUT MENTION OF CEREBRAL INFARCTION	6	12	18

ICD 9 CM	CODING	F	M	Tot
4353	VERTEBROBASILAR ARTERY SYNDROME	6	11	17
4320	NONTRAUMATIC EXTRADURAL HEMORRHAGE	9	8	17
43391	OCCLUSION AND STENOSIS OF UNSPECIFIED PRECEREBRAL ARTERY WITH CEREBRAL INFARCTION	8	8	16
43321	OCCLUSION AND STENOSIS OF VERTEBRAL ARTERY WITH CEREBRAL INFARCTION	8	7	15
43380	OCCLUSION AND STENOSIS OF OTHER SPECIFIED PRECEREBRAL ARTERY WITHOUT MENTION OF CEREBRAL INFARCTION	6	7	13
4376	NONPYOGENIC THROMBOSIS OF INTRACRANIAL VENOUS SINUS	10	1	11
43330	OCCLUSION AND STENOSIS OF MULTIPLE AND BILATERAL PRECEREBRAL ARTERIES WITHOUT MENTION OF CEREBRAL INFARCTION	4	2	6
43381	OCCLUSION AND STENOSIS OF OTHER SPECIFIED PRECEREBRAL ARTERY WITH CEREBRAL INFARCTION	1	4	5
4374	CEREBRAL ARTERITIS	2	3	5
4352	SUBCLAVIAN STEAL SYNDROME	3	2	5
43331	OCCLUSION AND STENOSIS OF MULTIPLE AND BILATERAL PRECEREBRAL ARTERIES WITH CEREBRAL INFARCTION	2	1	3
4375	MOYAMOYA DISEASE	1	1	2
4351	VERTEBRAL ARTERY SYNDROME	1	1	2