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*Research Article*

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# Comparative Analysis of Prehospital Response Times in Ischemic Stroke Cases: A Study from Verona Province

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## Abstract

**Introduction:** Ischemic stroke represents one of the most significant causes of morbidity and mortality worldwide, with early recognition and timely prehospital intervention playing a crucial role in improving overall patient outcomes. In Italy, stroke continues to be the second leading cause of death, with an annual incidence estimated to range between 95 and 290 cases per 100,000 inhabitants. Given the substantial burden of this condition, optimizing prehospital management is of paramount importance.

**Methods:** A retrospective observational study was conducted analyzing 1,051 emergency cards from the calendar year 2023 with a final diagnosis of ischemic stroke. After applying exclusion criteria, 944 cases were evaluated, managed by different emergency medical services: Nurse-staffed ambulances (MSI, n=762), helicopter emergency medical services (HEMS, n=20), physician-staffed ambulances (MSAn=33) and medical -car services (n=129). Primary outcomes measured were time on target for each service type and the impact of advanced airway management on these times. Comparative analysis was performed between different service types and between intubated *vs.* non-intubated patients.

**Results:** Both nurse-staffed (average: 22 min) and physician-staffed ambulances (average: 18 min) demonstrated significantly shorter time on target compared to medical car (average: 41 min for intubated patients, 29 min for non-intubated patients). HEMS maintained comparable times to nurse-staffed ambulances (average: 21 min for non-intubated patients, 25 min for intubated patients). The overall intubation rate for ischemic stroke patients was 1.23% (13/1,051), with similar rates between HEMS (10%) and road-based physician services (9%). Orotracheal intubation increased time on target by an average of 4 minutes for HEMS teams and 12 minutes for road-based physician teams.

**Conclusion and implications:** In conclusion, when responding to patients with a suspected ischemic stroke who are not expected to require advanced airway management, the most efficient and time-sensitive emergency medical response options are ambulances that are staffed either by nurses (MSI) or by physicians (MSA). These types of vehicles enable prompt on-scene assessment, stabilization and transportation to an appropriate medical facility without unnecessary delays.

However, in situations where a patient is experiencing a suspected stroke and is located at a considerable geographical distance from the nearest hospital equipped with a specialized stroke unit, the deployment of a Helicopter Emergency Medical Service (HEMS) should be prioritized. Due to its ability to cover long distances in a significantly shorter time frame, HEMS represents the most effective pre-hospital transport solution for these patients, ensuring that they reach definitive stroke care as quickly as possible.

 

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On the other hand, the use of self-medication services or the dispatch of a medical car (automedica) for this patient population has been associated with an average delay of approximately 10 minutes in initiating critical pre-hospital care, without offering any significant additional treatment advantages compared to nurse-staffed ambulances.

These findings offer essential insights and practical guidance for emergency medical dispatchers, enabling them to make more strategic and informed decisions regarding the optimal allocation of emergency resources. By improving pre-hospital response efficiency, these optimized dispatch strategies could contribute to reducing treatment delays, ultimately enhancing the overall quality of time-sensitive stroke care and improving patient outcomes.

**Keywords:** Ischemic stroke; Morbidity; Mortality; Prehospital intervention; Stroke survivors

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## Introduction

Ischemic stroke is the second leading cause of death in Italy, accounting for 9%-10% of all deaths (about 35,000 people each year) with an incidence of about 95-290 new cases per 100,000 inhabitants [1]. 20%-30% of stroke victims die within one month of the event and 40%-50% within the first year [2].

A significant percentage of ischemic stroke survivors (75%) survive with some form of disability and of these, half have a deficit so severe that they lose self-sufficiency. It is therefore the leading cause of disability in Italy, since only 25% of patients who survive a stroke recover completely. The outcome is highly dependent on diagnostic and therapeutic speed [2].

Ischemic stroke is therefore the cause of about 90,000 hospitalizations per year, 20% of which are relapses of a first event, thus having a major impact on the economy of the Italian National Health Service [2].

Every minute following the onset of ischemic stroke leads to the loss of approximately 2 million neurons, emphasizing the critical importance of early medical intervention [3]. The prehospital response system plays a vital role in reducing delays, thereby enhancing patient outcomes [4].

### Prehospital response system

The prehospital phase is divided into different stages, beginning with emergency call handling. A CO118 nurse carries out a telephone triage, assessing the patient's condition and determining the appropriate emergency response according to the regional D.I.R.E. dispatch system.

Potential emergency medical resources include both nurse- and physician-staffed vehicles. The selection of the most suitable response unit is guided by dispatch protocols. In certain cases, non-medical vehicles may be deployed, although this is a less favorable option for suspected ischemic stroke cases.

A key determinant of response efficiency is time on target, which refers to the duration medical personnel spend at the scene for assessment and stabilization [5]. This metric is crucial in optimizing prehospital stroke care and ensuring timely hospital admission.

The primary objective of this study is to analyze and compare the differences in “time on target” between nursing-staffed and physician-staffed emergency vehicles operating within the territory of Verona and its province when responding to patients with a suspected ischemic stroke [6,7]. Additionally, a secondary aim is to assess the extent to which the average “time on target” increases in patients who require endotracheal intubation compared to those who do not. Furthermore, this study seeks to examine the differences in intubation times between Helicopter Emergency Medical Services (HEMS) and ground-based medical vehicles, such as the Medical Car units [8-10]. By analyzing these data, it will be possible to derive specific operational guidelines and recommendations for the 118 emergency operations centres, allowing for a more informed and strategic decision-making process regarding the most appropriate type of emergency medical vehicle to be dispatched as a first-choice response for patients presenting with a suspected ischemic stroke.

## Materials and Methods

### Inclusion criteria

In this retrospective observational study, a comprehensive analysis was conducted on a total of 1,194 emergency response records collected throughout the 2023 calendar year. These records corresponded to emergency interventions in which the return of the emergency vehicle to the hospital occurred under a priority code 3, with a pre-alert notification sent to the triage team of the designated receiving hospital. Each of these hospitals was an active participant in the regional Stroke Network, equipped with a fully operational stroke

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unit and operating in accordance with the AOUI Verona inter-company stroke protocol [11-13].

Following an initial selection process, only the records that documented cases with a final confirmed diagnosis of ischemic stroke were retained for further evaluation. This refinement reduced the dataset to 1,051 eligible records. Cases in which the final return diagnosis was determined to be cerebral hemorrhage were systematically excluded from the analysis, leading to the removal of a total of 144 records from the dataset [3].

To ensure the accuracy and consistency of the data, additional exclusions were applied. These included the removal of duplicate or triplicate records, which resulted from instances where multiple emergency response teams were simultaneously involved in the same intervention. Moreover, records from medical services for which it was not possible to retrieve complete documentation were also excluded [14,15]. After implementing these criteria, a final total of 944 records remained available for analysis. These cases were subsequently categorized according to the type of emergency vehicle involved in the response, as follows:

- 762 cases managed by an MSI unit (nursing ambulance), with all patients breathing spontaneously (762 in total, 0 requiring intubation).
- 20 cases handled by HEMS (Helicopter Emergency Medical Service), with 18 patients maintaining spontaneous breathing and 2 requiring intubation.
- 33 cases managed by an MSA unit (medical ambulance), all of whom were spontaneously breathing (33 in total, 0 requiring intubation).
- 129 cases attended to by a medical car service, among which 118 patients were in spontaneous breathing, while 11 required intubations.

## Data analysis

The time on target of all the services taken into account was analyzed and the average between the events managed by MSI, by ambulance, by helicopter and by medicalized ambulance was taken [16].

With regard to the events managed by medicalized vehicles, the difference in timing was assessed between patients who required advanced airway management by means of Oro-tracheal intubation and patients who did not require this manoeuvre.

The data obtained were compared in order to derive the difference in timing between the various groups examined, also assessing the increase in timing in relation to the need for advanced airway management [17].

# Results

## Timings

Both the nursing (average: 22 min.) and the medical ambulances (average: 18 min) showed a significant decrease in the time on target compared to the average time on target when using the ambulances (average: 41 min if intubated patient, 29 min. if non-intubated patient) [18]. The helicopter maintains times on target in line with the average for ambulances (average: 21 min if patient not intubated, 25 min if patient intubated) [19].

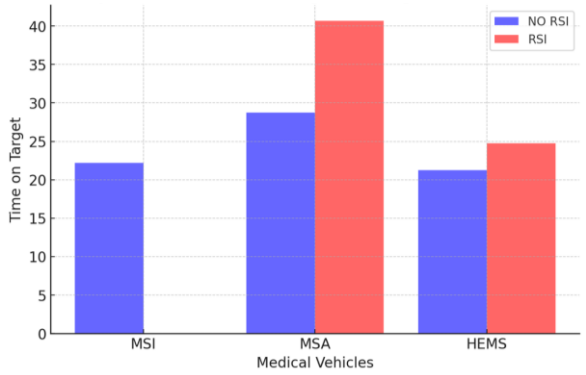
## Airway management

The intubation rate of a patient with an ischaemic stroke varies from 9% (11/118) of the MSA vehicle on rubber to 10% of the HEMS vehicle (2/20). The overall intubation rate of a patient with ischaemic stroke in the territory is 1.23% (12/1051).

Orotracheal intubation results in an average increase in time on target from 4 minutes for the HEMS team to 12 minutes for the MSA road team [20].

The rate of advanced airway management is 11% for the HEMS team versus 9% for the MSA road team.

There were no patients intubated by the medical ambulance and no need for advanced airway management by the MSI vehicles **(Figure 1)**.




| | MSI | MSA | HEMS |
|---|---|---|---|
| NO RSI | 22.18 | 28.74 | 21.24 |
| RSI | - | 40.69 | 24.76 |

**Figure 1:** Comparison of time on target among medical vehicles.

# Discussion

Possible reasons for the differences between the groups are as follows:

## Timing

- The medicalized ambulance has a lower time on target than other medical vehicles in that, as the crew consists of at least three figures (doctor nurse and driver), unlike nursing ambulances which consist of only two figures (nurse and driver), they are able to transport the patient from the scene to the ambulance more quickly.

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- The medicalized ambulance has a lower time-on-target than other medical vehicles because, as it always accompanies the patient from the target to the hospital, no time is used to write a report on the spot but this is likely to be done enroute.
- Nursing ambulances have a lower time-on-target than ambulances because the nursing assessment is closely linked to pre-hospital assessment scales and therefore quicker than a medical assessment, which is certainly more thorough but less effective in terms of timing.
- Nursing ambulances have a shorter time-on-target than self-medications because they do not need to draw up the report on site as is necessary for self-medications if they decide not to accompany the patient by medicalizing the vehicle, but to entrust the vehicle with the patient. The possibility of drawing up the report during transport can lead to a decrease in time on target.
- Helicopter rescue has a comparable time-on-target with nursing ambulances in that it, too, when transporting the patient, does not have to write the report on the spot but can write it during transport.
- Helicopter rescue has a time on target comparable with nursing ambulances in that it has a team of at least three members (doctor nurse, mountain rescue technician) and like the ambulances, can transport the patient from the target to the vehicle more quickly.

### Airway management

- Intubation rates are comparable between MSA road vehicles and HEMS vehicles.
- Overall intubation rates are very low, it is a condition that rarely requires the need for advanced airway management.
- The difference in intubation times between MSA road vehicles and HEMS vehicles could be explained by a different level of technical preparation for advanced orotracheal intubation manoeuvres between the teams of the two vehicles; in the case of the HEMS vehicle the team doctor is a doctor who is always a specialist in Anesthesia and Resuscitation, in Emergency-Urgency Medicine or in other specialties but with proven experience in pre-hospital emergency-urgency, while in the case of the MSA vehicle on wheels he may not be a specialist doctor and therefore may not have a high level of experience in pre-hospital emergency-urgency.

## Conclusions

- When determining the most effective and competitive emergency medical vehicles to be deployed as the primary response for patients presenting with a suspected ischemic stroke, it is essential to consider the patient's anticipated medical needs. In cases where there is no suspicion that the patient will require advanced airway management, the most suitable and efficient first-choice options are nursing ambulances (MSI) and Medical Ambulances (MSA). These vehicles are capable of providing immediate on-site medical assistance while ensuring that the patient is transported to an appropriate facility without unnecessary delays.
- However, when a patient is suspected of having a stroke and at the same time, is located a significant distance away from the nearest hospital equipped with a specialized stroke unit, the preferred mode of transportation should be a rotary-wing medical vehicle (HEMS). The rapid airborne transport offered by HEMS is particularly advantageous in these scenarios, as it substantially reduces pre-hospital time and facilitates quicker access to specialized stroke care.
- Conversely, opting to dispatch a medical car for this category of patients does not contribute any additional advanced treatment options beyond those already available with a nursing ambulance. Furthermore, this decision has been observed to result in an average delay of approximately 10 minutes in the initiation of patient care, potentially impacting the time-sensitive management of stroke without offering any significant clinical benefits.

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