PREHOSPITAL STROKE CARE, PARAMEDIC TRAINING NEEDS, AND HOSPITAL-DIRECTED FEEDBACK IN LITHUANIA

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ABSTRACT:

Background: Emergency medical services (EMS) are the first health care contact for the majority of stroke patients. However, there is a lack of data on the current paramedics' hospital-directed feedback and training needs across different health care settings. We aimed to evaluate paramedics' prehospital stroke care knowledge, training needs, and current status of feedback on suspected stroke patients.

Methods: We surveyed paramedics from the Vilnius region from September to November 2019, and compared the answers between the city and the district agencies. The questionnaire content included questions on paramedics' demographic characteristics, prehospital stroke care self-assessment, knowledge on stroke mimics, stroke training needs, and the importance of hospital-directed feedback on suspected stroke patients.

Results: A total number of 161 paramedics were surveyed, with more district paramedics rating their prehospital stroke care knowledge as inadequate (44.8% (95% confidence interval (CI) 32.8–57.6) vs 28.1% (95% CI 20.1–27.8), $p = 0.028$). In addition, more district paramedics indicated a need for additional stroke training (83.1% (95% CI 71.5–90.5) vs 69.8% (60.0–78.1), $p = 0.043$). However, respondents reported being the most confident while dealing with stroke (71.3%, 95% CI 63.8–77.7) compared to other time-critical conditions ($p < 0.001$). Vertigo (60.8%, 95% CI 53.0–68.0), brain tumours (56.3%, 95% CI 48.5–63.8), and seizures (54.4%, 95% CI 46.7–62.0) were indicated as the most common stroke mimics. Only 6.2% (95% CI 3.4–11.1) of respondents received formal feedback on the outcome of suspected stroke patients brought to the emergency department.

Conclusion: A high proportion of paramedics self-perceive having inadequate stroke knowledge and an urgent need for further stroke training. The EMS staff indicate receiving an insufficient amount of feedback on suspected stroke patients, even though the usefulness is perceived to be paramount.

Keywords: survey; emergency medical services; training; stroke; prehospital care.

KEY MESSAGES

What is already known on this topic

- Correct identification of stroke patients in the prehospital care setting remains problematic, as EMS staff fail to identify up to one-third of stroke patients.

- Data on the current paramedics' hospital-directed feedback and training needs across different health care settings are lacking.

What this study adds

- A high proportion of Lithuanian EMS specialists indicate having inadequate stroke knowledge and high stroke training needs, significantly more prominent in suburban agencies. Nevertheless, paramedics feel more confident dealing with stroke compared with other time-critical conditions.

- Although perceived to be insufficient, the usefulness of hospital-directed feedback on suspected stroke patients is considered to be paramount.

How this study might affect research, practice, or policy

- This is the first survey in Eastern Europe that targets the prehospital stroke care aspects and could be of considerable value in assessing the regional situation.

INTRODUCTION

Stroke is the second-leading cause of death and the third-leading cause of death and disability combined worldwide, and is estimated to increase by 27% by 2047[1,2]. It is a time-sensitive condition as accurate recognition and timely transport of patients with suspected stroke to the nearest stroke-ready hospital is closely correlated with acute stroke care success[3,4]. Emergency Medical Services (EMS) play a crucial role in early stroke recognition as they are the first health care contact in about two-thirds of stroke patients[5]. Therefore, how paramedics respond to stroke is paramount in reducing prehospital delays and improving patient outcomes[6,7].

Accurate EMS dispatch, rapid transportation, and hospital stroke team prenotification substantially reduce prehospital patient delays and significantly increase reperfusion treatment rates[8]. However, correct identification of stroke patients in the prehospital care setting remains problematic, as EMS staff fail to identify up to one-third of stroke patients[9]. Thus, comprehensive interventions are crucial to increase the quality of prehospital care.

One way to improve the quality of prehospital stroke care is through continuing professional development[10,11]. In addition, regular feedback to paramedics on their transported patients could also be an important tool that would enable learning from everyday practical experience[12,13]. However, data on the current paramedics' hospital-directed feedback and training needs across different health care settings is lacking.

Therefore, we used a standardized questionnaire to evaluate paramedics' prehospital stroke care knowledge, training needs, and current status of feedback on suspected stroke outcomes. In addition, we compared urban and suburban EMS agencies, hypothesising that the level of knowledge and access to medical training might differ based on the EMS location.

MATERIALS AND METHODS

Study design

We conducted a survey of Vilnius city and district paramedics between September and November 2019. A standardised paper questionnaire was distributed to all the EMS staff who participated in stroke care training at Vilnius University Hospital[11]. The questionnaire was based on a survey of the United Kingdom's (UK) paramedics, conducted by McClelland et al.[14] A Lithuanian version of the survey was used, adapted to the Lithuanian prehospital setting. The content

included questions on paramedics' demographic characteristics, prehospital stroke care self-assessment, knowledge on stroke mimics, stroke training needs, the importance of hospital-directed feedback on suspected stroke patients, and attitudes toward the current Lithuanian stroke network. Respondents were asked to rate their answers using a 5-point Likert scale. Answers were scored with 1 being the least confident/influence/change and 5 being the most. The English translation of the Lithuanian version of the survey is presented as **Supplementary Material 1**.

Setting

Essential emergency health services in Lithuania are free of charge and EMS are the first responders in the majority of medical emergencies. Each EMS unit in Lithuania is staffed by a two-person team – a specialist-paramedic, and a driver-paramedic[11]. In urban areas, each EMS unit can serve up to a maximum of 18,000 inhabitants, and up to 16,000 inhabitants in suburban areas. Our study was conducted among Vilnius city and district paramedics, employed by eight EMS agencies – one operating in an urban and seven in suburban municipalities, covering a catchment population of approximately 945,000 inhabitants. Collectively, in 2019 these EMS agencies were staffed by 326 specialists (214 in urban and 112 in suburban locations) and transported ≈ 20,400 patients, of whom an estimated 5.0% were suspected strokes. Vilnius district stroke patients are carried to one of the two comprehensive stroke centres in Vilnius or a primary stroke centre in Utena[15]. Following the National law, all EMS agencies across the country utilize identical dispatch protocols[16].

Ethics

Since the survey was voluntary and we obtained anonymised data without the ability to identify a specific person, no ethics approval was sought.

Statistical analysis

The data were reported descriptively with numerical and percentage frequencies. The χ2 test and Fisher's exact test were used for categorical variables, as appropriate. Based on the EMS location, urban and suburban areas were compared. Respondents, working in both urban and suburban EMS agencies, were excluded from the comparison. $P < 0.05$ (two-sided) was

considered statistically significant. IBM SPSS Statistics 23.0 software (Armonk, NY: IBM Corp) and R version 3.6.2 were used for statistical analyses.

RESULTS

Demographic characteristics

In total, 176 participants attended the stroke care training and filled out the questionnaire. Fourteen of them were excluded from the analysis as they were working in a hospital but not in the EMS, and one respondent was an administrator of the EMS agency. Therefore, we included 161 out of 326 (49.4%) paramedics from our stroke care network (**Table 1**). Based on their EMS agency location, 97 (60.2%) paramedics worked in Vilnius city, 59 (36.6%) in Vilnius district, and 5 (3.2%) − in both urban and suburban agencies. The majority of the EMS staff were women (74.5%), and more than two-thirds of the respondents belonged to age groups from 40 to 59 years (mean age 49.9±10.0 years). With only a small proportion of the paramedics being below the age of 40 years (13.4%), the majority of the EMS staff (72.0%) indicated a long-term experience of 21 years or more working in prehospital care. The surveyed EMS employees indicated having a degree of a community nurse (83.8%), a paramedic (13.8%), or a medical doctor (2.5%). Despite their previous education, all participants included are referred to as paramedics, as defined by the College of Paramedics[17].

Table 1. Characteristics of survey respondents included in the study (*n* = 161).

	n (%)
Female gender	120 (74.5)
Age range (years)	
20–29	10 (6.4)
30–39	11 (7.0)
40–49	53 (33.8)
50–59	58 (36.9)
60–69	24 (15.3)
70+	1 (0.6)
Experience in prehospital care (years)	
<2	6 (3.7)
3–5	14 (8.7)
6–10	8 (5.0)
11–20	17 (10.6)
21–30	58 (36.0)
31–40	44 (27.3)
41+	14 (8.7)
Ambulance employer	
Vilnius city	97 (60.2)
Vilnius district	59 (36.6)
Both	5 (3.2)
Education	
Community nurse	134 (83.8)
Paramedic	22 (13.8)
Medical doctor	4 (2.5)

Continuing professional development and stroke training

Statistically significantly more district than city paramedics rated their prehospital stroke care knowledge as inadequate (44.8% (95% CI 32.8–57.6) vs. 28.1% (95% CI 20.1–37.8), *p* = 0.028) (**Figure S1**). The vast majority of the respondents (97.5%, 95% CI 93.8–99.0) indicated that they had improved their prehospital stroke knowledge since the beginning of their careers. The most common continuing professional stroke development source was ambulance service-based courses (57.8%, 95% CI 50.0–65.1), followed by self-directed offline sources (47.2%, 95% CI

39.7–54.9), and lectures, seminars, or workshops (33.5%, 95% CI 26.7–41.1) (**Figure 1**). The difference in current prehospital stroke care knowledge is consistent with further results – more suburban than urban paramedics indicated the need for further individual prehospital stroke care training (83.1% (95% CI 71.5–90.5) vs 69.8% (95% CI 60.0–78.1), $p = 0.043$) (**Figure S2**). When asked about the need for continuous stroke training for EMS as a whole, high stroke training demand was indicated in city and district paramedics (85.1%, 95% CI 78.8–89.8).
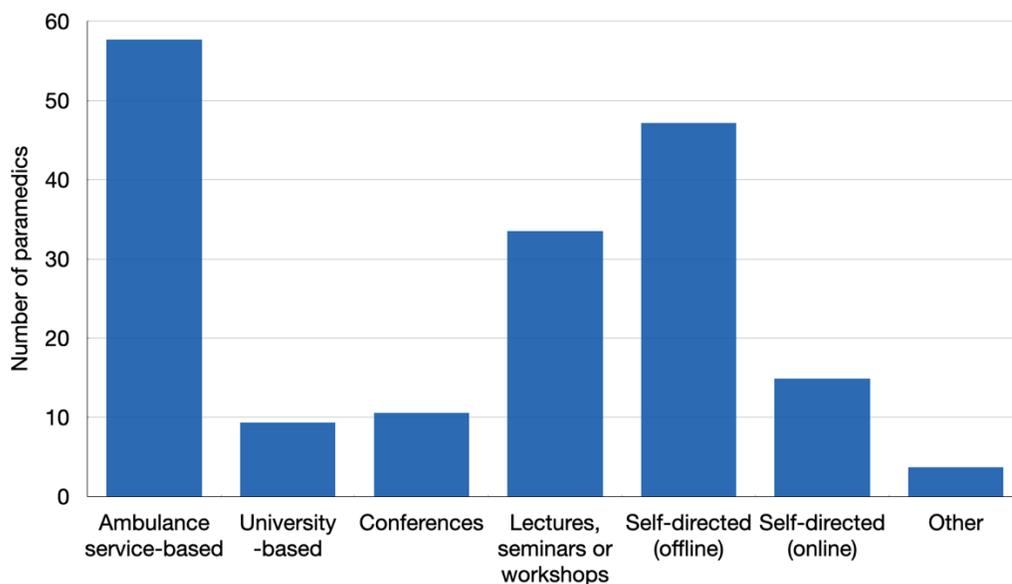
**Figure 1.** EMS stroke continuing professional development source.

Stroke versus other time-critical conditions

Respondents were asked to rate their confidence in dealing with patients in four time-critical conditions, using a 5-point Likert scale (**Figure 2**). The majority of the paramedics expressed the highest confidence while dealing with stroke (71.3% (95% CI 63.8–77.7), $p < 0.001$), followed by major trauma (60.0%, 95% CI 52.3–67.3), STEMI (48.1%, 95% CI 40.5–55.8), and sepsis (35.9%, 95% CI 28.8–43.6). When asked to what extent they thought the prehospital actions influence the patient outcome (**Figure S3**), the respondents rated that their actions have the most influence when dealing with STEMI (98.1%, 95% CI 94.7–99.4) and major trauma (97.5%, 95% CI 93.8–99.0), followed by stroke (91.3%, 95% CI 85.9–94.8) and sepsis (84.5%, 95% CI 78.1–89.3).
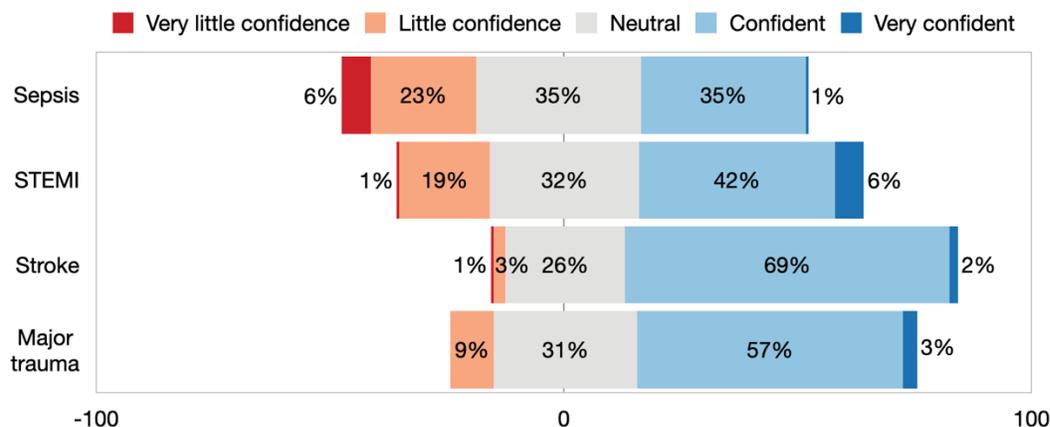
Figure 2. How respondents rated their confidence dealing with time-critical conditions.

Lastly, the surveyed paramedics indicated that similar prehospital care improvement trends during their career were observed in all of the four time-critical conditions (**Figure 3**) – the most in major trauma (95.0%, 95% CI 90.4–97.4), stroke (93.8%, 95% CI 88.9–96.6), and STEMI (93.1%, 95% CI 88.1-96.1), and the least improvement was noted in sepsis care (80.6%).
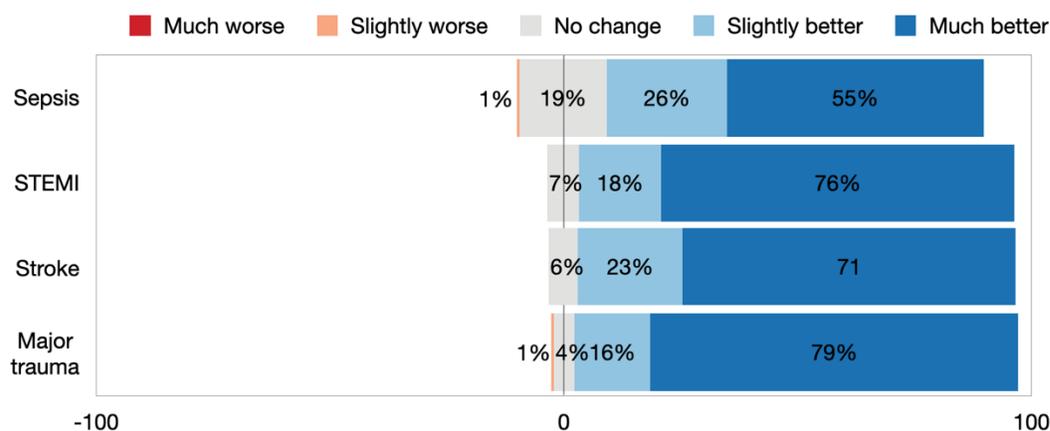
Figure 3. Respondents were asked how they thought prehospital care has changed over the course of their career.
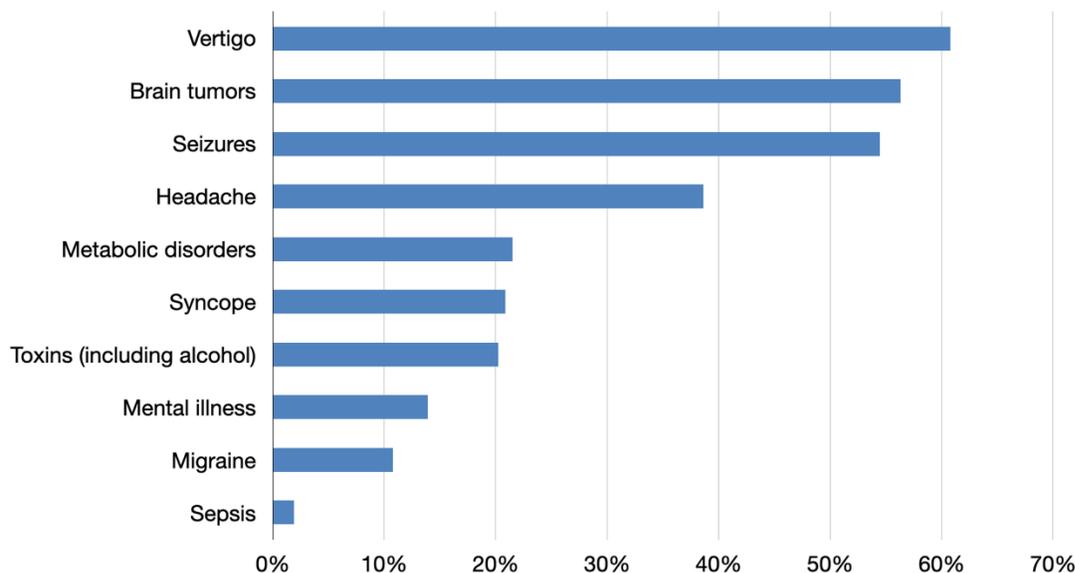
Stroke mimics

The majority of the surveyed paramedics (26.6%, 95% CI 20.0-34.4) estimated that the proportion of prehospital suspected stroke patients that were ultimately given a stroke mimic diagnosis ranges from 20 to 29 per cent (**Figure 4**).
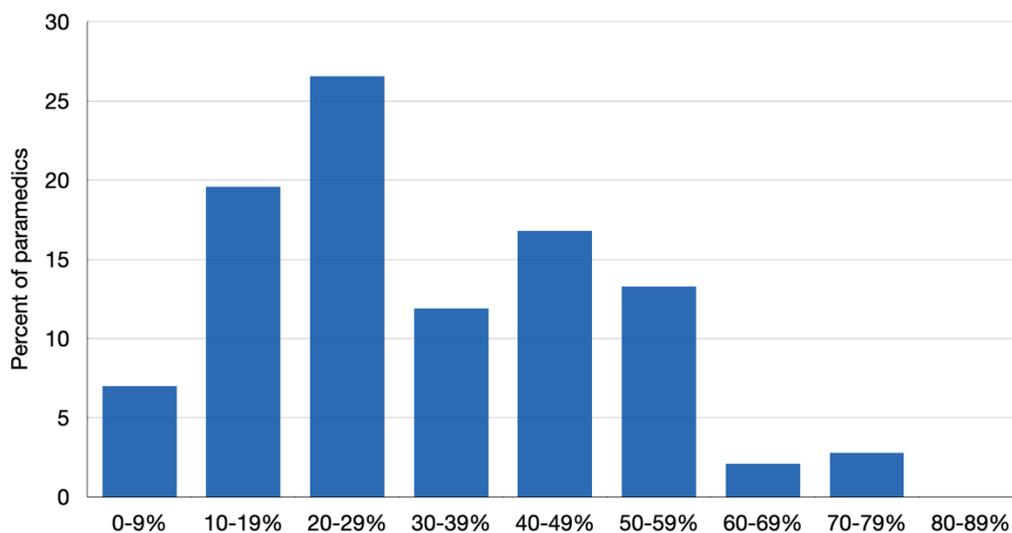
Figure 4. EMS estimates of the proportion of prehospital suspected stroke patients with a stroke mimic diagnosis.

When asked which three conditions were the most common stroke mimics in the prehospital setting (**Figure 5**), the respondents indicated them being vertigo (60.8%, 95% CI 53.0–68.0), brain tumours (56.3%, 95% CI 48.5–63.8), and seizures (54.4%, 95% CI 46.7-62.0).

Figure 5. Conditions EMS staff thought were the three most common prehospital stroke mimics.

Feedback

Overall, 112 (70.4%, 95% CI 62.9–77.0) of the surveyed EMS staff agreed on the usefulness of hospital-directed feedback on suspected stroke outcomes (**Figure S4**). However, insufficient feedback was observed. Fifty-five (34.2%, 95% CI 27.3–41.8) paramedics reported not receiving any feedback at all, 96 (59.6%, 95% CI 51.9–66.9) noted occasionally receiving informal feedback, and only 10 (6.2%, 95% CI 3.4–11.1) indicated regularly receiving formal feedback.

Attitude toward the Lithuanian stroke network

When asked about their attitude toward the current Lithuanian stroke care system, 30 (19.4%, 95% CI 13.9–26.3) of the respondents were very positive, 102 (65.8%, 95% CI 58.0–72.8) – positive, 18 (11.6%, 95% CI 7.5–17.6) – neutral, and only 5 (3.2%, 95% CI 1.4-7.3) expressed a negative or very negative view (**Figure S5**).

DISCUSSION

This survey on prehospital stroke care, training needs, and hospital-directed feedback provided us with several main findings. First, we found a high proportion of EMS specialists who indicated having inadequate stroke knowledge and high stroke training needs, significantly more prominent in suburban agencies. Second, paramedics felt more confident dealing with stroke than with other time-critical conditions despite the inadequate self-perceived stroke knowledge. Third, we found

that paramedics receive an insufficient amount of hospital-directed feedback on suspected stroke patients, even though the usefulness of such feedback was considered of high significance. We discuss the possible reasons and implications below.

Our survey revealed that the absolute majority of the EMS staff have continued to improve their prehospital stroke care skills since the beginning of their careers. However, only a third of respondents marked having participated in lectures, seminars, or workshops and only one in ten paramedics participated in university-based curriculum and conferences. Similar stroke continuing professional development proportions were found in a UK paramedics' survey, although involvement in any continuing professional development training was at least twice as high[14].

In addition, significantly more suburban paramedics rated their prehospital stroke care knowledge as inadequate and indicated significantly higher stroke training demand for EMS as a whole, although an overwhelming training demand was observed in both groups. These findings are in line with other studies, showing that EMS staff members lacked stroke care knowledge[8,14,18], and regional disparities were present[19]. Studies assessing the real-world impact of EMS training show that it improves stroke recognition, increases hospital prenotification rates, improves tPA delivery time[10,11], and stroke transfer time to the ED[3]. As emphasized by the European[3] and North American guidelines[20], it is crucial to maintain the continuity of EMS education. This is especially important in response to ever-changing external factors, such as global public health emergencies[5,21] or changes in the standard operating procedures due to the advent of telemedicine and Mobile Stroke Units[22–25]. The shifting landscape of prehospital stroke care puts the spotlight on EMS training to improve prehospital stroke care competencies.

Despite the high demand for stroke training, paramedics expressed being most confident in dealing with stroke among other time-critical conditions. In comparison, a similar survey revealed that the UK paramedics were most confident in contact with sepsis, STEMI, and stroke patients, and the least confident when dealing with major trauma[14]. These differences might occur due to different exposure to certain conditions in prehospital care and varying availability of evidence-based guidelines. However, this could also indicate that EMS staff members might lack sufficient training or evidence-based guidelines for other time-critical conditions, despite the fact that responsibilities in the prehospital care field will continue to grow, therefore, continuous EMS retraining will be crucial[19,26]. In comparison, the UK paramedics expressed the least influence, and improvement in prehospital care when dealing with stroke[14].

Our survey revealed that only 6.2% of paramedics receive formal feedback on stroke, however, more than two-thirds of them think that hospital-directed feedback is crucial and would improve their future decision-making. These findings are in line with other studies, where formal feedback is noted as highly desirable for EMS staff members, yet not sufficient[8,10,12–14,18,27–29]. Previous studies have shown that hospital-directed feedback to EMS is associated with improved overall compliance with state protocols, increased hospital prenotification, and improved stroke timeliness metrics in patients with ischemic stroke[12].

Most of the surveyed paramedics estimated that the proportion of stroke mimics ranges from 20 to 29 per cent, consistent with the real-world situation[5,14,30]. The most common stroke mimics indicated by the paramedics were vertigo, brain tumours, and seizures. Indeed, a previous study found seizures, vertigo, and hypertensive encephalopathy to be the three most common stroke mimics, with brain tumours being the seventh most common mimic[5]. Although similar trends have been observed in other studies, common stroke mimics may differ depending on a specific health care setting. For example, studies in the UK indicate seizure, migraine, sepsis, and syncope being the most common stroke mimics[8,14], whereas, a Norwegian study noted infection, seizures, and dizziness or vertigo[31]. This highlights an enormous spectrum of diseases to be considered for the differential diagnosis of stroke, further emphasising the important role that continuous professional development plays in improving prehospital stroke care[5].

Lastly, the current stroke network was recognized positively by almost 9 out of 10 EMS staff members. Previous studies have shown that a Lithuanian comprehensive national stroke care policy has resulted in significant trend improvements in reperfusion treatment rates, and a sustained significant decreasing trend of all-cause in-hospital case-fatality rates in stroke centres[15]. Future studies should aim to evaluate prehospital stroke care performance measures on the national level to investigate if the subjective positive assessment is based on stroke outcome improvements.

The main strength of our study was that, to our knowledge, this is the first survey in Eastern Europe that targeted the prehospital stroke care aspects. As Eastern Europe belongs to a very high cardiovascular risk region[32], there is an urgent need to study ways of improving the time-sensitive prehospital stroke care. Given that EMS staffing models and dispatch systems bear resemblance to other countries in the region[33,34], the results could be of considerable value in assessing the regional situation.

The main limitation of our study was that only half of the Lithuanian EMS agencies were involved in the survey. However, both urban and rural paramedic agencies have been represented, national regulations are imposed throughout the country, and all of the paramedics, participating in the EMS training, agreed to complete the survey. Thus, there should not be a high rate of bias.

CONCLUSIONS

Our survey revealed that a high proportion of Lithuanian EMS specialists indicate having inadequate stroke knowledge and high stroke training needs, significantly more prominent in suburban agencies. Despite the inadequate self-perceived stroke knowledge, paramedics feel more confident dealing with stroke compared with other time-critical conditions. Finally, the paramedics receive an insufficient amount of feedback on suspected stroke patients, even though the usefulness is perceived to be paramount.

CONFLICT OF INTEREST

None to declare.

SOURCES OF FUNDING

None to declare.

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AUTHOR CONTRIBUTIONS

Conceptualization, Rytis Masiliūnas, Aleksandras Vilionskis and Dalius Jatužis; Data curation, Kazimieras Melaika, Rytis Masiliūnas; Formal analysis, Kazimieras Melaika and Rytis Masiliūnas; Investigation, Kazimieras Melaika and Rytis Masiliūnas; Methodology, Rytis Masiliūnas, Aleksandras Vilionskis, Dalius Jatužis and Lukas Sveikata; Project administration, Kazimieras Melaika and Rytis Masiliūnas; Supervision, Aleksandras Vilionskis and Dalius Jatužis; Validation,

Adam Wiśniewski, Kristaps Jurjans and Andrius Klimašauskas; Visualization, Rytis Masiliūnas; Writing – original draft, Kazimieras Melaika and Rytis Masiliūnas; Writing – review & editing, Lukas Sveikata, Aleksandras Vilionskis, Adam Wiśniewski, Kristaps Jurjans, Andrius Klimašauskas and Dalius Jatužis. All authors will be informed about each step of manuscript processing including submission, revision, revision reminder, etc. via emails from our system or assigned Assistant Editor.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study did not require an Ethics Committee approval.

INFORMED CONSENT STATEMENT

Verbal informed consent was obtained from all EMS staff involved in the study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1 Collaborators G 2019 S, Feigin VL, Stark BA, *et al.* Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurology* 2021;20:795–820. doi:10.1016/s1474-4422(21)00252-0

2 Wafa HA, Wolfe CDA, Emmett E, et al. Burden of *Stroke* in Europe: Thirty-Year Projections of Incidence, Prevalence, Deaths, and Disability-Adjusted Life Years. Stroke 2020;51:2418–27. doi:10.1161/strokeaha.120.029606

3 Kobayashi A, Czlonkowska A, Ford GA, et al. European Academy of Neurology and European Stroke Organization consensus statement and practical guidance for pre- hospital management of stroke. *Eur J Neurol* 2018;25:425–33. doi:10.1111/ene.13539

4 Emberson J, Lees KR, Lyden P, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. Lancet 2014;384:1929–35. doi:10.1016/s0140-6736(14)60584-5

5 Melaika K, Sveikata L, Wiśniewski A, et al. Changes in Prehospital Stroke Care and Stroke Mimic Patterns during the COVID-19 Lockdown. *Int J Environ Res Pu* 2021;18:2150. doi:10.3390/ijerph18042150

6 Mueller-Kronast N, Froehler MT, Jahan R, et al. Impact of EMS bypass to endovascular capable hospitals: geospatial modeling analysis of the US STRATIS registry. *J Neurointerv Surg* 2020;12:1058–63. doi:10.1136/neurintsurg-2019-015593

7 Zhang S, Zhang J, Zhang M, et al. Prehospital Notification Procedure Improves Stroke Outcome by Shortening Onset to Needle Time in Chinese Urban Area. *Aging Dis* 2018;9:426. doi:10.14336/ad.2017.0601

8 Li T, Munder SP, Chaudhry A, et al. <p>Emergency Medical Services Providers' Knowledge, Practices, And Barriers To Stroke Management</p>. *Open Access Emerg Medicine* 2019;Volume 11:297–303. doi:10.2147/oaem.s228240

9 Abboud ME, Band R, Jia J, et al. Recognition of Stroke by EMS is Associated with Improvement in Emergency Department Quality Measures. *Prehosp Emerg Care* 2016;20:1–8. doi:10.1080/10903127.2016.1182602

10 Oostema JA, Chassee T, Baer W, et al. Brief Educational Intervention Improves Emergency Medical Services Stroke Recognition. Stroke 2019;50:1193–200. doi:10.1161/strokeaha.118.023885

11 Sveikata L, Melaika K, Wiśniewski A, et al. Interactive Training of the Emergency Medical

Services Improved Prehospital Stroke Recognition and Transport Time. *Front Neurol* 2022;13:765165. doi:10.3389/fneur.2022.765165

12   Choi B, Tsai D, McGillivray CG, et al. Hospital-Directed Feedback to Emergency Medical Services Improves Prehospital Performance. Stroke 2018;45:2137–40. doi:10.1161/strokeaha.114.005679

13   Eaton-Williams P, Mold F, Magnusson C. Effective clinical feedback provision to ambulance clinicians: a literature review. *J Paramedic Pract* 2020;12:109–17. doi:10.12968/jpar.2020.12.3.109

14   McClelland G, Flynn D, Rodgers H, et al. A survey of UK paramedics' views about their stroke training, current practice and the identification of stroke mimics. *Br Paramedic J* 2017;2:4–15. doi:10.29045/14784726.2017.2.1.4

15   Masiliūnas R, Vilionskis A, Bornstein NM, et al. The impact of a comprehensive national policy on improving acute stroke patient care in Lithuania. *European Stroke J* 2022;:239698732210891. doi:10.1177/23969873221089158

16   Ministry of Health of The Republic of Lithuania. n.d.https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.437212/asr (accessed 10 May 2022).

17   Eaton G. Paramedic. noun. Br Paramedic J 2019;4:1–3. doi:10.29045/14784726.2019.09.4.2.1

18   Brunton L, Boaden R, Knowles S, et al. Pre-hospital stroke recognition in a UK centralised stroke system: a qualitative evaluation of current practice. Br Paramedic J 2019;4:31–9. doi:10.29045/14784726.2019.06.4.1.31

19   Williams I, Valderrama AL, Bolton P, et al. Factors Associated with Emergency Medical Services Scope of Practice for Acute Cardiovascular Events. Prehosp Emerg Care 2011;16:189–97. doi:10.3109/10903127.2011.615008

20   Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2019;50:e344–418. doi:10.1161/str.0000000000000211

21   Suppan M, Stuby L, Carrera E, et al. Asynchronous Distance Learning of the National Institutes of Health Stroke Scale During the COVID-19 Pandemic (E-Learning vs Video): Randomized Controlled Trial. *J Med Internet Res* 2021;23:e23594. doi:10.2196/23594

22   Grotta JC, Yamal J-M, Parker SA, et al. Prospective, Multicenter, Controlled Trial of Mobile Stroke Units. *New Engl J Med* 2021;385:971–81. doi:10.1056/nejmoa2103879

23 Ebinger M, Siegerink B, Kunz A, et al. Association Between Dispatch of Mobile Stroke Units and Functional Outcomes Among Patients With Acute Ischemic Stroke in Berlin. *Jama* 2021;325:454–66. doi:10.1001/jama.2020.26345

24 Ramanathan RS, Wisco D, Vela-Duarte D, et al. Pre-Hospital Diagnosis in Mobile Stroke Unit. *J Stroke Cerebrovasc Dis* 2021;30:105801. doi:10.1016/j.jstrokecerebrovasdis.2021.105801

25 Phillips D, Grunwald IQ, Walter S, et al. Mobile stroke unit in the UK healthcare system: avoidance of unnecessary accident and emergency admissions. Br Paramedic J 2021;5:64–64. doi:10.29045/14784726.2021.3.5.4.64

26 Koivulahti O, Tommila M, Haavisto E. The accuracy of preliminary diagnoses made by paramedics – a cross-sectional comparative study. *Scand J Trauma Resusc Emerg Medicine* 2020;28:70. doi:10.1186/s13049-020-00761-6

27 Pollard J, Black S. DO PARAMEDICS FIND IT BENEFICIAL TO LEARN THE DIAGNOSIS GIVEN TO THEIR PATIENTS IN THE EMERGENCY DEPARTMENT? *Emerg Med J* 2015;32:421. doi:10.1136/emermed-2015-204877.2

28 Cash RE, Crowe RP, Rodriguez SA, et al. Disparities in Feedback Provision to Emergency Medical Services Professionals. Prehosp Emerg Care 2017;21:1–9. doi:10.1080/10903127.2017.1328547

29 McGuire SS, Luke A, Klassen AB, et al. It's Time to Talk to Prehospital Providers: Feedback Disparities among Ground-Based Emergency Medical Services Providers and its Impact on Job Satisfaction. *Prehospital Disaster Medicine* 2021;36:486–94. doi:10.1017/s1049023x21000601

30 Gibson L, Whiteley W. The differential diagnosis of suspected stroke: a systematic review. *J Royal Coll Physicians Edinb* 2013;43:114–8. doi:10.4997/jrcpe.2013.205

31 Khanevski AN, Kvistad CE, Novotny V, et al. Incidence and Etiologies of Stroke Mimics After Incident Stroke or Transient Ischemic Attack. Stroke 2019;50:2937–40. doi:10.1161/strokeaha.119.026573

32 Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. *Eur J Prev Cardiol* 2022;29:5–115. doi:10.1093/eurjpc/zwab154

33 Karliński M, Gluszkiewicz M, Członkowska A. The accuracy of prehospital diagnosis of acute cerebrovascular accidents: an observational study. *Archives Medical Sci Ams* 2015;11:530–5. doi:10.5114/aoms.2015.52355

34 Kozera-Strzelińska D, Karliński M, Rak G, et al. Stroke and TIA mimics in patients referred to a neurological emergency department by non-ambulance physicians, ambulance physicians and paramedics. *Neurol Neurochir Pol* Published Online First: 2018.

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