

Dispatcher Stroke/TIA Recognition in Emergency Medical Call Center and Out-of-Hours Service Calls in Copenhagen, Denmark

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Abstract

Background and Objectives

Recognition of stroke/TIA symptoms by emergency medical services (EMS) is instrumental in providing timely recanalization treatments. We assessed the recognition of stroke/TIA by EMS via the emergency medical call center (EMCC) dispatchers and out-of-hours health service (OOHS) dispatchers.

Methods

In a registry study, based on 2015–2020 data from the Copenhagen EMS, we calculated sensitivity, positive predictive value (PPV), specificity, and negative predictive value (NPV) of dispatcher suspicion of stroke or transient ischemic attack (TIA) and compared against discharge diagnosis.

Results

We included 462,029 contacts to EMCC and 2,573,865 contacts to OOHS. In total, 19,798 contacts had a stroke or TIA diagnosis at hospital discharge. Sensitivity was 0.64 for EMCC dispatchers and 0.25 for OOHS. PPV was 0.28 for EMCC and 0.22 for OOHS; specificity was 0.96 for EMCC and >0.99 for OOHS, and NPV was 0.99 for EMCC and >0.99 for OOHS. Sensitivity improved over the period of the study from 0.62 to 0.68 for EMCC and from 0.20 to 0.25 for OOHS. PPV did not change over the period for EMCC and decreased from 0.26 to 0.19 for OOHS. Both EMCC and OOHS more frequently overlooked stroke in women, in patients calling more than 3 hours after symptom onset, and for more severe strokes. For OOHS, advanced age correlated with lower recognition.

Discussion

As the first study reporting on OOHS setting dispatcher stroke/TIA recognition, we find a need for the improvement of stroke/TIA recognition both in EMCC and in OOHS. Solutions may include specific training of dispatchers, public awareness campaigns, and new technological solutions.

Introduction

When symptoms of stroke/TIA occur in Denmark, patients and bystanders primarily contact the emergency medical services (EMS), either emergency medical call center (EMCC) or out-of-hours health services (OOHS),¹ where EMS recognition of stroke/TIA is imperative.²

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Accurate and swift diagnoses are a prerequisite for good outcomes in stroke/TIA.^{3,4} Attempted revascularization with intravascular thrombolysis (IVT) and endovascular thrombectomy (EVT) are effective, although time dependent.^{3,4}

The recognition of stroke/TIA among EMS dispatchers varies.⁵⁻⁹ Previous studies report positive predictive values (PPV) between from 0.09 to 0.68 and sensitivities range from 0.41 to 0.93.⁵⁻⁹ Both specificity and negative predictive value (NPV) are generally reported as high, ranging from 0.86 to 0.99 and 0.90 to 0.99⁵, respectively. Although stroke recognition by EMCC dispatchers has been investigated previously, there has not been published data on OOHS dispatcher recognition of stroke, although a substantial number of stroke patients contact OOHS.

We therefore aimed to investigate the accuracy of stroke or TIA recognition by dispatchers at EMCC and OOHS operated by Copenhagen EMS from 2015 to 2020.

Methods

Organization of Emergency Services

Copenhagen EMS is organized as an integrated service with 2 individual call lines. The “1813 - Medical Helpline” is an OOHS service, for nonacute cases during hours where general practitioners are inaccessible. OOHS medical dispatchers are trained nurses or physicians with knowledge regarding acute illness.

The “1-1-2 – Emergency Helpline,” the EMCC, is for acute emergencies, where all dispatchers are trained nurses or paramedics. The 2 phone lines (1813 and 1-1-2) are run by the same EMS department, from which ambulances can be dispatched, and patients can be referred to emergency departments. Both lines are staffed 24 hours a day, 7 days a week. Copenhagen EMS also hosts call lines for nonacute transport of patients and physician-manned lines used for supervision, none of which receive acute patient calls directly. The dispatchers at both phone lines are additionally trained according to a standard 6-week course in emergency triage and the use of the national computer referral and dispatch system (Dansk Index), including stroke visitation. Furthermore, stroke recognition focusing of BE-FAST symptoms¹⁰ and triage has been the theme of several educational staff meetings during the study period.

All calls are recorded and saved, where records of information provided during calls are collected in a patient-administrative dispatch system (Logis Cad) and linked to the subjects' unique civil registration number (CPR-number, elaborated in data sources section) when possible. The cases where it is not possible to link a call to the CPR number are almost exclusively in the EMCC. In these cases, the caller is usually not the patient, and the CPR number is not added to the call log after ambulance transport, perhaps because of it being unknown to the ambulance personnel or the caller at the time. This amounts to a very low percentage of calls (1%–3%).

Both EMCC and OOHS use an index coding system, during telephone triage of patients according to symptoms and suspected diagnoses. The index system is categorized into specific disease groups. When choosing a group, it opens a “next level” of more specific illnesses. There are no specific questions required to be asked, but an index symptom must be chosen before finalizing the call. Dispatchers select the level of emergency response, where the fastest is labelled “A,” denoting the use of ambulance with “lights and sirens.” The second fastest is labelled “B,” and so forth until “E.”¹¹ In daily practice, “A” (as fast as possible), “B” (arrival at call location inside 30 minutes), and “C” (arrival within approximately 60 minutes) constitutes most responses. In accordance with current Danish neurovascular treatment guidelines, patients with suspected stroke or TIA should be triaged as either an “A” or a “B” response (second fastest) when stroke or TIA is suspected, respectively. The guidelines recommend this because immediate admittance to a stroke unit, regardless of advanced treatment, has previously been shown to improve functional outcomes.¹²

Data Sources

We retrieved data from 2 registry cohorts: Danish Stroke Registry (DAP)¹³ and administrative data from the dispatch systems at Copenhagen EMS.

All Danish residents are assigned a CPR-number, which is used administratively in the public sector, including by public health providers. Furthermore, upon in-hospital diagnosis of acute stroke or TIA, submission of information to DAP, including, but not limited to, time of symptom onset, is required of treating stroke units. It is mandatory to register all strokes/TIAs diagnosed at a Danish hospital who have symptom onset within 5 days in DAP. This is regardless of whether the patient is seen in a ward or the emergency department. The Danish Stroke Registry has a completeness of 93%–95% when compared with the National Patient Register, which also includes strokes diagnosed more than 5 days from symptom onset.

The DAP registry thus provides data on all patients with stroke or TIA treated in Danish hospitals, tied to their unique CPR-number.¹³

We included call data from between 2015 and 2020. We identified patients diagnosed with stroke (either ischemic or haemorrhagic) or TIA via the merger of EMS and DAP data, coupled by CPR-numbers. We chose to include both ischemic and haemorrhagic stroke because the 2 entities cannot be differentiated by clinical symptoms alone. As TIA diagnosis is registered in DAP at hospital discharge, the symptoms had not necessarily abated at the time of call, and therefore, TIA was included. Data were anonymized before statistical analysis.

Study Definition of Stroke/TIA Recognition

We defined successful recognition of stroke or TIA by medical dispatchers by both the dispatcher's use of a stroke/TIA-specific index code and the dispatchers' choice of a

correct emergency response (dispatch of an ambulance “A” or “B” for stroke or TIA suspicion, respectively). We defined failed recognition of stroke/TIA dispatchers’ choice of a nonstroke index criteria or the choice of an index criteria specific for stroke/TIA but with incorrect triage, inconsistent with treatment guidelines, regardless of the time elapsed since symptom onset.

We included calls to EMS between 2015 and 2020. We excluded calls where the patients were below 18 years, patients with subarachnoid haemorrhage, and missing data on index symptom or response. SAH was excluded because symptoms and treatment are distinctly different from the other stroke subtypes because of the classical symptoms of sudden onset of headache. Including SAH, patients may misrepresent the dispatcher’s ability to correctly recognize the more common stroke subtypes.

For classification as stroke/TIA, patients needed to have had a stroke/TIA diagnosis (ICD-10 codes: DG459, DI63x and DI61x) and had to have called emergency services (1-1-2 or 1813) within 3 days of recorded symptom onset in DAP. To accommodate for recall bias and imprecise registration in DAP, we also included calls registered as occurring within 24 hours before the onset of symptoms in the stroke/TIA group because DAP registration is based on patients’ recollection by full days if patients does not recall the precise point in time. Choosing 3 days as the cut-off also meant we included all patients with stroke who contacted the OOHS over the weekend, when their general practitioner was closed.

To minimize the risk of including patients admitted for other diseases than stroke/TIA, but who had a subsequent stroke during admission, we limited the time for included calls to 24 hours before registered symptom onset.

Outcomes

Our primary outcome was sensitivity of the dispatchers’ suspicion of stroke/TIA.

We also calculated PPV, specificity, and NPV of suspected stroke/TIA and analysed all measures for change over time. We further investigated whether recognition of stroke/TIA was affected by the age and sex of the patients, early contact after symptom onset, or severity of symptoms. The severity of symptoms was based on the Scandinavian Stroke Scale,¹⁴ which is an internationally used stroke severity scale where stroke symptoms are scored in 9 domains: Gait, speech, eye movement, consciousness, orientation, facial palsy, arm motor power, hand motor power, and leg motor power. Symptom severity is based on the combined “score” from symptoms, with maximum being 58 corresponding to no symptoms. The score is registered in DAP as mild (45–58 points), moderate (30–44 points), severe (15–29 points), very severe (0–14points), and unknown (missing points total).¹⁵

Statistics

We calculated the sensitivity, PPV, specificity, and NPV and their 95% confidence intervals for correct diagnosis of stroke/TIA by EMCC or OOHS dispatchers, where analyses were repeated for individual years to detect change over time. We tested for significance using Cochran-Armitage test of trend.

We anticipated a high specificity and NPV because of the expected large amount of non-stroke/TIA calls. We defined statistical significance as $p < 0.05$ in all analyses. In case of missing data, contacts were excluded from analysis.

The potential influence of sex, age (based on 25% quartiles, with the first quartile as baseline), calling within 3 hours of symptom onset, and symptom severity was assessed using logistic regression analyses, and odds ratios (OR) as well as 95% confidence intervals were reported. We chose 3 hours as the cut-off to allow time for transportation and patient assessment before the closure of the IVT window. By doing this, we aimed to investigate whether dispatchers mainly focused on the IVT window of 4.5 hours when handling stroke calls and thereby disregarded the need for at fast admittance of all stroke patients regardless of the time of onset.

Data were analysed using R (version i386 4.1.1) and Rstudio statistical software made by Free Software Foundation, Boston Massachusetts, USA.

Standard Protocol Approvals, Registrations, and Patient Consents

This study was approved by the Danish Data Protection Agency (P-2021-475). Since data were retrieved from registers, approval from the Scientific Ethics Committees is not required as per Danish law.

Data available from corresponding author upon reasonable request.

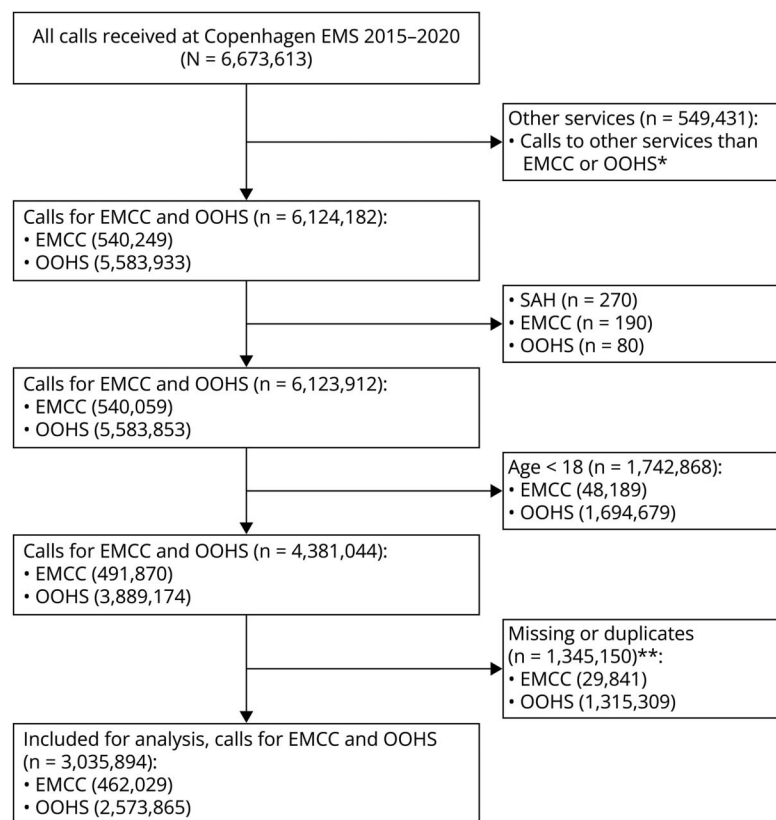
Results

Study Population

As illustrated in Figure 1, we analysed 6,673,613 calls to EMS Copenhagen where 540,249 calls taken by EMCC and 5,583,933 by OOHS. We excluded 549,431 calls from which either were from other emergency services or health care personnel or had missing data, as specified with the study design. Then, after the removal of duplicate calls and adjustment for inclusion and exclusion criteria, we included 462,029 calls to EMCC and 2,573,865 calls to OOHS (Figure 1) for analysis.

Characteristics of patients with stroke/TIA who called are shown in Table 1. Characteristics that potentially correlate with higher recognition are illustrated by odds ratios for recognition of subgroups compared with a predefined baseline and shown in Figure 2.

Figure 1 Number of Emergency Medical Call Center and Out-of-Hours Health Service Calls Included in Copenhagen, Denmark, From 2015 to 2020



The EMCC = emergency medical call center; OOHS = out-of-hours health service; SAH = subarachnoid hemorrhage. *Copenhagen EMS receives calls regarding planned transport for hospitals, calls from other authorities as police or municipal care, which are excluded from the analysis. **Calls with missing data on response level, criteria code, or personal identifier are excluded.

Of all calls to EMCC and OOHS, 10,893 and 8,905 called because of stroke/TIA symptoms, respectively (Table 2).

Dispatchers recognized stroke/TIA with a sensitivity of 0.64 (95% CI 0.63–0.65) at EMCC and 0.25 (95% CI 0.24–0.26) at OOHS. The PPV was 0.28 (95% CI 0.27–0.29) for EMCC and 0.22 (95% CI 0.21–0.23) for OOHS. Specificity was 0.96 (95% CI 0.96–0.96) for EMCC and >0.99 (95% CI >0.99, >0.99) for OOHS, and NPV was 0.99 (95% CI 0.99, 0.99) for EMCC and >0.99 (95% CI >0.99, >0.99) for OOHS (Table 2).

Figure 3 provides a visual representation of the 2 populations and stroke/TIA recognition.

Sensitivity, PPV, Specificity, and NPV for EMCC Dispatcher and OOHS Dispatcher by Year

For EMCC, there was a significant ($p < 0.01$) increase in sensitivity from 0.62 to 0.68 but no significant difference in PPV ($p = 0.39$) during the study period (Figure 4, see eTables, links.lww.com/CPJ/A464 including the number of cases per year). Specificity or NPV did not change over time (see eTables).

For OOHS, there was a significant ($p < 0.01$) increase in sensitivity from 0.20 to 0.25 and a significant ($p < 0.01$)

decrease in PPV from 0.26 to 0.19 during the study period. There was no significant change in specificity or NPV over time (Figure 4 and eTables, links.lww.com/CPJ/A464).

Subgroup Analyses of Sex, Time Since Onset, and Patient Age

In subgroup analyses, we investigated the differences in stroke/TIA recognition when grouping the calls according to sex, age, or calling within or after 3 hours of symptom onset using logistic regression. In the EMCC group, the stroke/TIA recognition was significantly higher in men, with OR for recognition in men vs women 1.16 (95% CI 1.07–1.25; $p < 0.01$) and higher in the group where the call was made within 3 hours from symptom onset, OR 1.28 (95% CI 1.18–1.40; $p < 0.01$).

For age, group analyses based on 25% quartiles using the first quartiles as baseline showed no significant difference between groups. Using “mild” severity as baseline, recognition was significantly lower for severity degrees “very severe” and “unknown” (Figure 2).

In the OOHS, we found a significantly higher OR of men vs women 1.15 (95% CI 1.05, 1.27; $p < 0.01$) and higher recognition when the call was within 3 hours of symptom onset with OR 1.63 (95% CI 1.48, 1.80; $p < 0.01$). There was a

Table 1 Characteristics of Patients With Stroke/TIA or Transient Ischemic Attack Who Called the Emergency Medical Call Center or the Out-of-Hours Health Service in Copenhagen, Denmark, From 2015 to 2020

Stroke/TIA calls to the emergency medical call centre (1-1-2)			
	Stroke/TIA recognized (n = 7,003) (%)	Stroke/TIA not recognized (n = 3,890) (%)	p Value ^a
Female	3,119 (62.5)	1,874 (37.5)	
Male	3,884 (65.8)	2,016 (34.2)	
Age—Mean (SD) (y)	72.4 (12.8)	72.6 (13.4)	
Call within 3 hours of symptom onset	5,079 (66.0)	2,617 (34.0)	<0.01
Call outside 3 hours of symptom onset	1,924 (60.2)	1,273 (39.8)	<0.01
Mild symptoms	4,546 (65.3)	2,418 (34.7)	<0.01
Moderate symptoms	1,286 (66.9)	636 (33.1)	<0.01
Severe symptoms	650 (66.0)	336 (34.0)	<0.01
Very severe symptoms	401 (51.5)	377 (48.5)	0.22
Unknown severity of symptoms	120 (49.4)	123 (50.6)	0.79
Stroke/TIA calls to the out-of-hours health service (1813)			
	Stroke/TIA recognized n = 2,202 (%)	Stroke/TIA not recognized (n = 6,703) (%)	p Value ^a
Female	990 (23.3)	3,250 (76.7)	
Male	1,212 (26.0)	3,453 (74.0)	
Age—Mean (SD) (y)	69.7 (13.8)	71.0 (14.2)	
Call within 3 hours of symptom onset	1,333 (29.1)	3,252 (70.9)	<0.01
Call outside 3 hours of symptom onset	869 (20.1)	3,451 (79.9)	<0.01
Mild symptoms	1833 (25.6)	5332 (74.4)	<0.01
Moderate symptoms	229 (22.0)	812 (78.0)	<0.01
Severe symptoms	76 (23.0)	255 (77.0)	<0.01
Very severe symptoms	44 (19.7)	179 (80.3)	<0.01
Unknown severity of symptoms	20 (13.8)	125 (86.2)	<0.01

^a For difference between recognized and unrecognized groups (Students T-test).

significantly lower stroke/TIA recognition in the fourth age quartile, spanning from 82-105. Using “mild” severity as baseline, recognition was significantly lower for severity degrees “moderate,” “very severe,” and “unknown” (Figure 2).

For sex disaggregated analyses, see eTables (links.lww.com/CPJ/A464).

Discussion

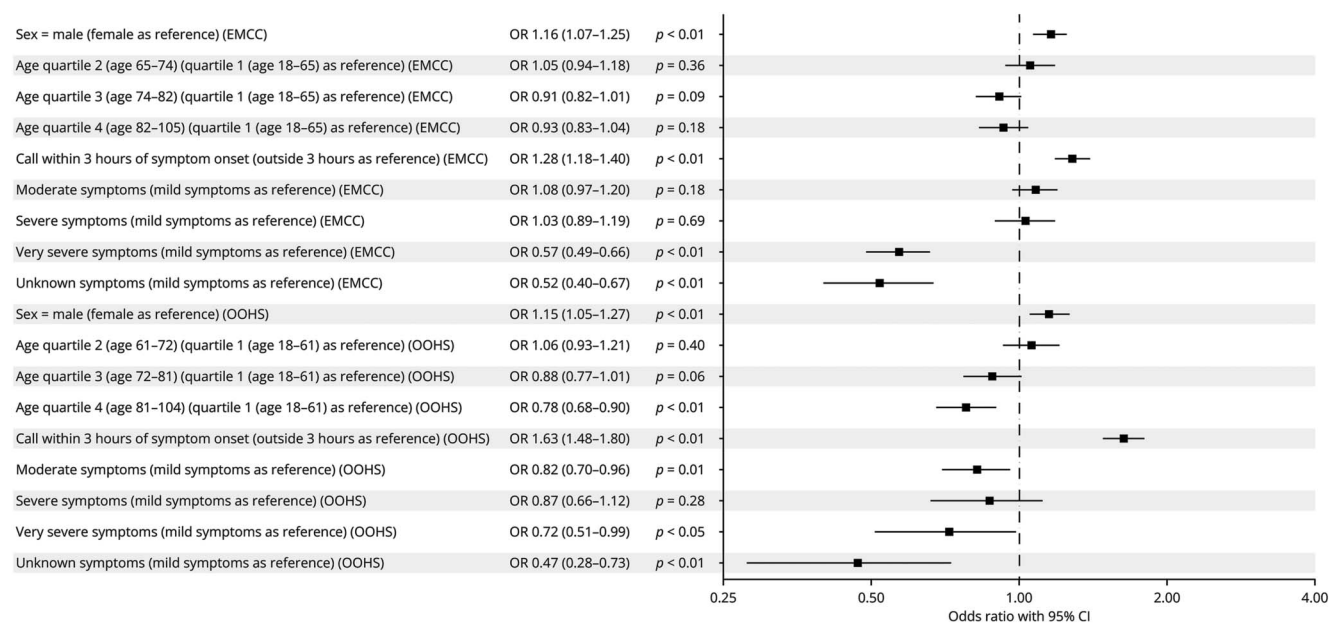
This is one of the largest studies on EMCC and OOHS dispatcher recognition of stroke/TIA, and one of the first directly comparing the 2 modes of contact. Although we found a slightly increased sensitivity in both settings, improvements are needed in the EMCC and more so in the OOHS where PPV declined over time. We demonstrated

reduced stroke/TIA recognition for female patients and that stroke/TIA recognition declined with time from symptom onset, which warrants further investigation.

It is concerning, especially because of the time-dependent nature of stroke/TIA treatment, that more than one third of acute stroke/TIA related calls to EMCC were unrecognized at first contact, with only one in 4 recognized by OOHS (Figure 3). In addition, in patients suspected by EMCC and OOHS dispatchers to suffer from stroke/TIA more than 70% were found to have other diagnoses after a work-up in hospital.

The sensitivity of EMCC dispatchers was compatible with previous studies (0.41 to 0.93⁵⁻⁹); however, PPV of 0.28 was low (0.09 to 0.68⁵⁻⁹). During the study period, the sensitivity of EMCC dispatchers increased significantly ($p < 0.01$),

Figure 2 Odds Ratios of Subgroup Recognition of Stroke/TIA in Copenhagen, Denmark, From 2015 to 2020



CI = confidence interval; EMCC = emergency medical call centre; OOHS = out-of-hours health service; OR = odds ratio.

whereas PPV was unchanged (Figure 4), suggesting improved recognition without an increase in nonstrokes referred to hospital on suspicion of stroke.

Table 2 Emergency Medical Call Center and Out-of-Hours Health Service Dispatcher Recognition of Stroke/TIA in Copenhagen, Denmark, From 2015 to 2020

	True stroke/TIA	Not stroke/TIA	Total
Suspected stroke/TIA (n)			
EMCC	7,003	17,995	24,998
OOHS	2,202	7,908	10,110
Not suspected stroke/TIA (n)			
EMCC	3,890	433,141	437,031
OOHS	6,703	2,557,052	2,563,755
Total			
EMCC	10,893	451,136	462,029
OOHS	8,905	2,564,960	2,573,865
	EMCC	OOHS	
Sensitivity	0.64 (0.63, 0.65)	0.25 (0.24, 0.26)	
Specificity	0.96 (0.96, 0.96)	>0.99 (>0.99, >0.99)	
Positive predictive value	0.28 (0.27, 0.29)	0.22 (0.21, 0.23)	
Negative predictive value	0.99 (0.99, 0.99)	>0.99 (>0.99, >0.99)	

Abbreviations: EMCC = Emergency medical call centre; OOHS = Out-of-hours health service.

Regarding OOHS, comparisons with previous publications are difficult because the current Danish setup is relatively unique internationally. Hence, this study provides the first reported data on stroke/TIA recognition by OOHS in Denmark. Thus, our study results could aid in pinpointing potential pitfalls of local OOHS, which should be considered if the Copenhagen EMS solution were to be disseminated to other EMS systems.

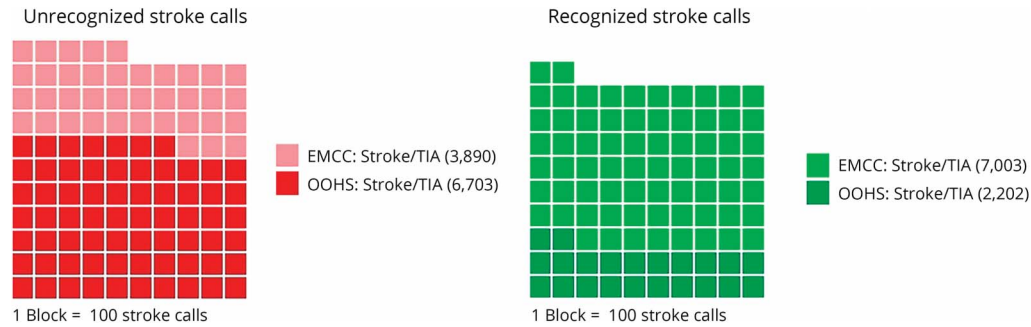
During the study period, the sensitivity of OOHS dispatchers increased (Figure 4). However, we found a significant decrease in PPV ($p < 0.01$), indicating a corresponding increase in nonstrokes referred to hospital on suspicion of stroke.

A low PPV could indicate a high degree of awareness of stroke as a potential diagnosis. However, because of finite hospital resources, this heightened awareness must be balanced by a heightened ability to correctly identify stroke/TIA.

As expected, specificity and NPV was high in both populations. Previous studies have reported specificity and NPV ranging from 0.86 to 0.99 and 0.90 to 0.99⁵, respectively. A few studies do report lower outliers of specificity in ranges from 0.15 to 0.50, and one reports a NPV of 30.9⁹.

The results for the OOHS dispatchers differ from those of the EMCC. Because this study is a retrospective and registry based, causality cannot be established; however, there are possible explanations for the low OOHS sensitivity of 0.25 and PPV of 0.22 compared with the higher sensitivity of 0.64 and PPV of 0.28 of EMCC (Figure 4). Patients with stroke/TIA often prefer to contact their GP or OOHS, instead of alerting

Figure 3 Stroke/TIA Recognition in the Emergency Medical Call Center and the Out-of-Hours Health Service in Copenhagen, Denmark, From 2015 to 2020



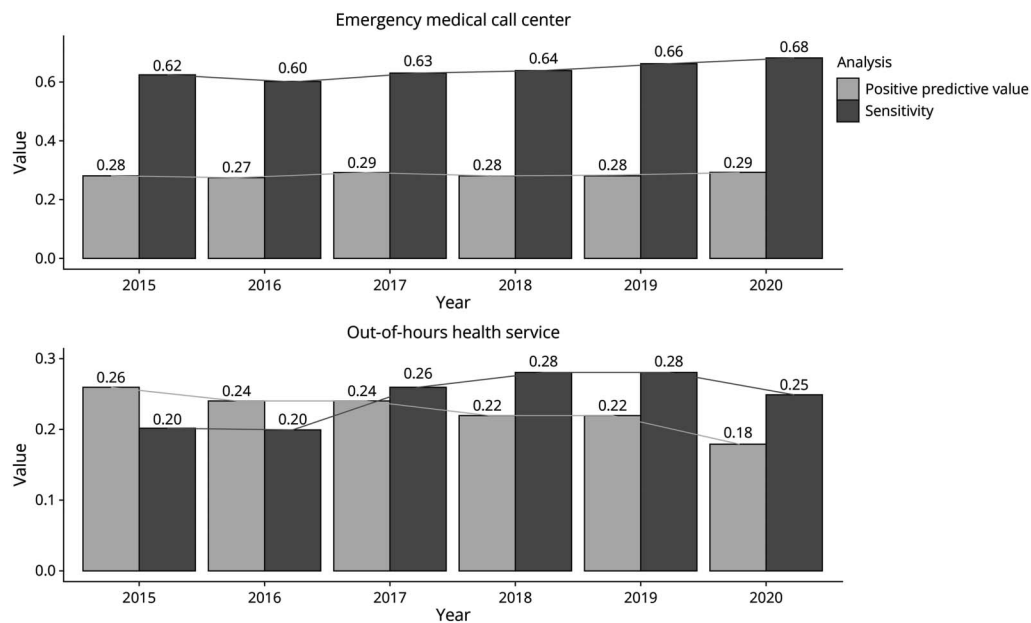
1 square = 100 patients with stroke/TIA; EMCC = emergency medical call center; OOHS = out-of-hours health service.

emergency services.¹⁶ Not contacting EMCC potentially associates with having mild or uncharacteristic symptoms or that the patients or bystanders did not consider the symptoms as an acute medical emergency^{17,18} prompting a call to OOHS, as opposed to the EMCC. In addition, mild or uncharacteristic symptoms may complicate telephonic recognition of stroke/TIA. In support hereof, we found that callers to the OOHS waited longer before calling compared with calls to EMCC, perhaps because of milder symptoms (Table 1). The low sensitivity and PPV found for OOHS dispatchers may also be affected by the relative low number of stroke/TIA-related calls to OOHS consistent with a lower prevalence of strokes/TIAs

in OOHS calls (8,905 strokes or TIAs/2,573,865 total calls) than among EMCC calls (10,893 strokes or TIAs/462,029 total calls) (Table 2). This difference contributes to lower PPV and higher NPV in OOHS than in EMCC.

The observed differences in sensitivity and PPV between the EMCC and the OOHS merit consideration. Both dispatcher groups are medically trained personnel and should therefore be comparable in diagnostic ability if strokes or TIAs present similarly in both settings. The large difference observed requires improvement of stroke/TIA recognition especially in the OOHS setting.

Figure 4 Sensitivity and Positive Predictive Value of Dispatcher Stroke/TIA Recognition Over Time in the Emergency Medical Call Center and the Out-of-Hours Health Service in Copenhagen, Denmark, From 2015 to 2020



A potential contribution to the increase in sensitivity from 2015 to 2020 for both groups of dispatchers is increased stroke/TIA awareness among both care personnel and the general population. In the final years of the study period, a national stroke awareness campaign was conducted in Denmark starting in September 2019 and onwards,¹⁹ with the initial campaign targeting the health care personnel. This does not, however, explain the change before 2019.

The increased sensitivity of OOHS dispatchers over time was also seen in EMCC, but the concomitant decrease in PPV was not seen in the EMCC results. This can potentially be attributed to an increased awareness over time of the importance of stroke/TIA recognition among OOHS dispatchers combined with low prevalence of stroke calls to the OOHS. An increase in suspected strokes/TIAs by OOHS dispatchers, and with only few extra strokes/TIAs identified, would inevitably cause an increased number of false positives.

Both the EMCC and OOHS dispatchers had lower stroke/TIA recognition in women and when calls were made later than 3 hours after symptom onset (Figure 2). In addition, in the OOHS population, advanced age (fourth age quartile, age 82–105) correlated with lower stroke/TIA recognition.

Our observed discrepancy between the sexes, regarding stroke recognition, may reflect differences in the way stroke presents in the sexes, as previous research suggests.^{20,21} The lower recognition when calls were more than 3 hours removed from symptom onset may reflect lack of awareness in the dispatchers on the importance of a full workup for stroke patients, even when advanced treatment is not an option.

It would have been interesting to analyse patterns because of race/ethnicity, country of origin, and primary language; however, this was not possible with the available data.

There was a larger proportion of severe strokes/TIAs in the EMCC calls compared with the OOHS (Table 1). Nevertheless, this difference cannot explain the observed discrepancy in stroke/TIA recognition, which was lower for “very severe” strokes/TIAs among EMCC calls (Figure 2) and for “moderately severe” and “very severe” stroke/TIA calls among OOHS (Figure 2). This was in contrast to our a priori assumption that milder strokes/TIAs with less prominent symptomatology would be difficult to identify. These findings could be because of impaired communication when symptoms are severe or imprecise registration of stroke suspicion by the dispatcher when dealing with hyperacute critical illness, but we do not have the data to investigate this further at this time.

Our data can be used to inform both the necessity and target of future stroke/TIA awareness campaigns and dispatcher training.

These data can be used to compare future studies intending to improve stroke/TIA recognition. Based on these results, it would be relevant for OOHS services in different settings to investigate dispatcher stroke recognition because most of unrecognized strokes in our data set contact the OOHS.

There are some limitations to our study. As a registry study, we cannot establish causality. Several calls were excluded because of missing data or CPR-numbers. We chose cut-offs for stroke/TIA diagnosis based on the time from onset; hence, we inevitably excluded some patients with stroke/TIA who called later than 72 hours after onset. We also included calls up to 24 hours before registered symptom onset to limit recall bias, which may cause inclusion of nonstroke calls. This could lead to underestimating the sensitivity and overestimating the positive predictive value.

There was a high number of calls excluded because of missing data. The missing data were mostly because of missing index codes, which did not allow us to ascertain the illness suspected by dispatchers. Such may have skewed data with a risk of overestimating dispatcher sensitivity. A small number of unmatched strokes could be because of unregistered citizens with temporary CPR numbers, which are not registered with EMS. Finally, because of the way data registration was done, some calls from patients with stroke may have been labelled as “false positive” if the call did not match with a CPR number. However, this would only be the case in a very small number of calls.

The 2 EMS branches studied had a different prevalence of stroke/TIA calls, complicating the interpretation of our results. We chose to use sensitivity, specificity, PPV, and NPV in our calculations, in accordance with the previous publications allowing potential future comparisons.

The stroke severity scale is the stroke scale applied for all patients in DAP throughout the years. Only patients receiving thrombolysis are evaluated according to the now more widely used “gold standard” NIHSS. To compare SSS and NIHSS, a conversion scale can be applied as previously suggested elsewhere.²²

The integrated EMCC and OOHS in Copenhagen EMS is not practiced in other regions of Denmark nor in other countries which hampers extrapolation to other EMS organizations. Although this can be seen as a limitation, it also provided us with a comprehensive overview of stroke/TIA patient behaviour because the population is most commonly studied from either EMCC or OOHS point of view. In our study, we could follow the stroke/TIA patient both before and in hospital, regardless of which service they contacted.

Our study also has several strengths. Our sample is large and based on robust registries with wide inclusion criteria to minimize sample bias. We included data from 5 years, making

TAKE-HOME POINTS

- Stroke/TIA is often unrecognized in emergency medical service calls.
- Out-of-hours health services especially struggles with stroke/TIA recognition.
- Women and patients calling more than 3 hours after symptom onset are less likely to be recognized as patients with stroke.
- With stroke/TIA recognition only improving marginally over time, new approaches are needed for to ensure further improvement of dispatcher stroke/TIA recognition.

it possible to detect changes over time. We included calls occurring up to 24 hours before patient reported onset, and thereby limiting the effect of patient recall bias.

In conclusion, in calls to EMS, both to the EMCC and the OOHs, many patients with stroke/TIA are not identified and may miss out on acute stroke/TIA treatment. Furthermore, a large group of patients are also misclassified as strokes/TIAs, more so for the OOHs than the EMCC. This study illustrates a significant need for establishing means to increase medical dispatchers' recognition of stroke/TIA in addition to increasing public awareness of stroke/TIA.

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