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Transport strategy for ischaemic stroke patients with large vessel occlusion

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ABSTRACT

Introduction. There are today two models of transporting patients with acute ischaemic stroke because of large artery occlusion (AIS-LVO): mothership (MS) and drip-and-ship (DS). Our aim was to evaluate our ongoing transport strategy (OT), which is an MS/DS hybrid. In our OT, the patient is transported directly to the CT of the Primary Stroke Centre (PSC), where intravenous thrombolysis (IVT) is administered. The patient then continues without delay to a Comprehensive Stroke Centre (CSC) with the same medical rescue team (MRT). The distance between our centres is 73 km.

Material and methods. We retrospectively analysed data of 100 consecutive AIS-LVO patients treated with mechanical thrombectomy (MT) between January 2017 and October 2019. OT, MS and DS groups were compared. 31 patients were transported as MS, 32 as DS, and 37 as OT.

Results. DS had significantly longer time to groin puncture (185 min) compared to OT and MS ($p < 0.0001$). OT shortened time almost to MS level (OT 124 min, MS 110 min, $p = 0.002$. Time to IVT administration (from MRT departure) differed statistically significantly in favour of OT (OT 27 min, MS 63 min, $p < 0.0001$). Logistical change in PSC had a significant effect on decreasing the door-to-needle time (DNT) median from 37 min to 11 min ($p < 0.0001$). DNT reduction also occurred in patients with AIS and without an indication for MT.

Conclusions. OT is highly effective, significantly reducing the time to IVT administration, and combining all the benefits, while eliminating all the disadvantages, of DS and MS. The OT concept gives all indicated patients a chance for MT to be performed, and does not overload the performing centre.

Key words: ischaemic stroke, large vessel occlusion, intravenous thrombolysis, mechanical thrombectomy, transfer

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Introduction

In connection with the introduction of mechanical thrombectomy (MT) as the standard treatment for acute ischaemic stroke (AIS), there has been a need to change pre-hospital care logistics so that patients — MT candidates — are treated as soon as possible. This change mainly affects areas where most patients are primarily directed to non-MT centres. In the Czech Republic, there are primary stroke centres (PSC), from which transport to a higher centre is required (i.e. a CSC, Comprehensive Stroke Centre). An important role is also played by the early onset of IVT, which should be performed if it is indicated. Patients treated with IVT and subsequently with MT clearly benefit from this approach [1].

The aim of our study was to evaluate selected key logistical time intervals and clinical results in patients subject to various transport options.

Material and methods

Currently, two main logistical approaches are most commonly discussed. The first is a concept called 'drip-and-ship' (DS). Here, the patient is transported from the field to the nearest stroke centre, where they are examined and treated with intravenous thrombolysis (IVT). If a large artery occlusion (LVO) is found, the patient is transported to a centre where MT is performed. The advantage of this concept is the selection of indicated patients in primary centres and the prompt administration of IVT. The main disadvantage of this concept is the significant time loss caused by secondary transport to secondary centres to MT, including delays in arranging transport.

The second approach is the direct transport of the patient to the centre performing the MT — the so-called 'mothership' (MS) concept. The main advantage is the elimination of time lost due to secondary transport from primary centres. The main disadvantage is both a higher load on CSC patients who do not eventually meet the criteria for MT, and a significant increase in time to IVT, which may be the only possible treatment for some patients (in the absence of an LVO, endovascular treatment is not technically feasible) [2].

For the centre, the advised candidate for MT can often mean bringing an unnecessary halt to an elective interventional case. The challenge of dentifying patients with a cerebral artery occlusion in the field based on an indicative clinical emergency medical examination is also a significant limitation.

Currently, various concepts for identifying suitable candidates are being tested using simple clinical tests with different sensitivities and specificities. In the Czech Republic, the FAST PLUS test is used in a number of regions; it has a sensitivity of 95% and a specificity of 52%. The positive predictive value for LVO is 51% and negative up to 96% [3].

The current (ESO-ESMINT 2019) recommendation states that if the arrival time to the nearest CSC is 30–45 min, patients who are potential candidates for MT should be transferred directly to the CSC. If the transport time is longer, the patient should head to the nearest PSC [4].

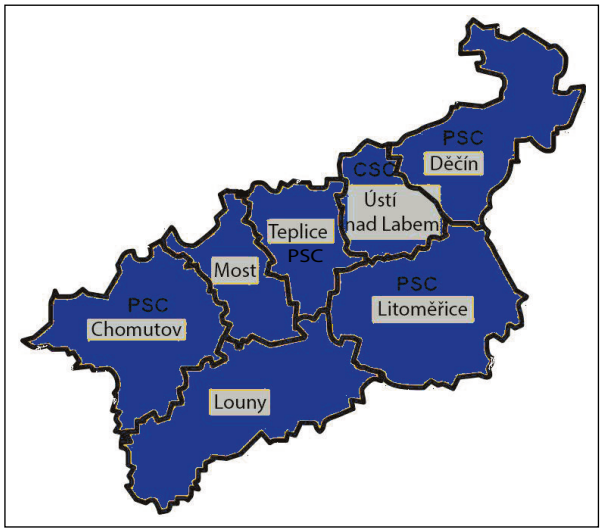

Figure 1. Stroke centres in Usti nad Labem region of Czech Republic. CSC — comprehensive stroke centre; PSC — primary stroke centre

In the Ústí nad Labem Region of the Czech Republic, where 850,000 inhabitants live in an area of 5,400 km^2, a third approach is currently preferred, one which is a combination of direct and secondary transport. We refer to this as ongoing primary transport (OT). The stroke network of the Ústí nad Labem Region (Fig. 1) consists of one CSC (MN UL) and four PSCs (Chomutov — CV, Teplice — TPC, Děčín — DC, and Litoměřice — LTM). From the place of stroke, the patient is referred to the nearest available PSC (prenotification to a dedicated stroke mobile phone) by the emergency services. If the patient is evaluated as a positive triad after telephone consultation with the centre's physician — and he or she meets the clinical (positive FAST test) and time criteria (< 24h) — the emergency medical service (EMS) is directly at the CT workplace. There will be both acute examination (NIHSS determination, blood pressure measurement, bedside glucose measurement with glucometer and INR on a Coagucheck device, blood serum, blood count and coagulation parameters, brain CT, ASPECT score, CTA of cerebral arteries) and early initiation of IVT if the indication criteria are met.

If symptomatic LVO is detected, a telephone consultation with the interventional radiologist (CSC MN UL) is immediately begun and the radiologist has direct access to the pictures via the archiving and communication system (PACS). This approach presupposes functioning communication and cooperation between EMS-PSC and PSC-CSC (interventional radiologist) and also the optimisation of hospital logistics within individual centres. We see advantages in the early initiation of IVT in PSC, and in patient transport to CSC to MT only in clearly indicated cases, in terms of the elimination

of delay in providing secondary transport (i.e. the patient is not hospitalised in the PSC and continues with the same emergency group), in terms of the intervention team being prepared when the patient arrives at the CSC, and also in terms of the fact that at the CSC angio-line, the elective programme is stopped exclusively in the indicated situations. The disadvantage is the higher demands on the above-mentioned PSC-CSC-EMS cooperation [5].

Until April 2018, the PSC CV catchment area included three regions with an area of 2,289 km^2 (Chomutov district, Louny district, and part of Most district) and a population of about 268,000. In normal conditions, the distance between the individual region of the PSC CV catchment area and CSC MN UL ranges from 40–45 min (45–50 km) up to 90–100 min (110–115 km). The Most district is alongside the road through Chomutov, Teplice and Ústí nad Labem. Therefore, due to better accessibility and shorter travel distance to the CSC MN UL (average 40 min), the logistics of patient transport with stroke was re-evaluated in April 2018 and part of the Most district was assigned into PSC TPC. Therefore, at present the PSC CV catchment area consists of Louny district and Chomutov district, including part of the mountains (area 2,056 km^2, population 211,000). Time distance between PSC CV and CSC MN UL is 53 min in standard driving conditions (71 km).

In the period from January 2017 to April 2018, LVO patients from the PSC CV catchment area were transported to CSC MN UL to MT either according to the DS or the MS approach. Within the drip-and-ship approach, a positive emergency medical service patient was first brought to the emergency clinic PSC CV after the trial. After the necessary supplementation of anamnesis and acute examinations (NIHSS, measurement of blood pressure, determination of glycaemia with glucometer and INR on a Coagucheck device, sampling for blood serum, blood count and coagulation parameters), the patient was transferred to the CT workplace for examination of the brain and cerebral arteries. IVT was initiated at the CT workplace, and in the case of AIS-LVO a secondary transport to the CSC to MT was organised. MS was used especially in cases where the distance from the place of stroke to CSC MN UL was < 45 min, during full anticoagulant treatment, or when hemiplegia was found in a younger patient instead of stroke. Since April 2018, the standard approach has been OT (see the description above) and only exceptionally MS transport (e.g. in cases of a failure of the CT device in the PSC CV).

Our retrospective study included all patients the PSC CV catchment area who were treated with MT in CSC Ústí nad Labem from January 2017 to October 2019. All patients were admitted to the PSC Chomutov or CSC after telephone advice on the basis of positive triage. Symptomatic occlusion of cerebral artery to CTA was found in all patients. IVT was initiated in all patients who met the indication criteria. Patients were transported to the CSC in MS, DS or OT mode.

MT was performed with stent retrievers (Solitaire®, Catch Device® and Trevo®). The achieved recanalisation status was evaluated according to modified Thrombolysis in Cerebral Infarction Scale (mTICI) on the final angiogram [6].

In all patients, the incidence of intracerebral haemorrhage (ICH) was assessed on control CT or MR after 24 hours. Symptomatic ICH (SICH) was defined as local distant parenchymal haematoma (type 2) or subarachnoid haemorrhage associated with at least a four-point increase in NIHSS scores or leading to death [7].

Neurological deficit was assessed by NIHSS in 24 hours and clinical outcome in three months using the modified Rankin Scale (mRS). A score of 0–2 was considered a good clinical outcome. The evaluation of mRS was performed by experienced neurologists, mostly during planned outpatient visits.

In order to evaluate time intervals, it was necessary to select an independent reference point. This independence (based on EMS work, estimated time of origin, weather and traffic conditions) was met by the virtual time being set as the time of arrival at the first centre, reduced by the time of arrival from the hit point (i.e. the time set by the unified navigation device under normal traffic conditions for each hit).

STATISTICA 12.0 was used for statistical data processing. Significance tests were also used in addition to the basic descriptive characteristics. Due to a non-normal frequency distribution, non-parametric statistical procedures (Mann Whitney test, Kruskal Wallis test) and Chi square test of independence were used. Data normality was tested using the Shapiro Wilcoxon test.

In all cases, the null hypothesis was rejected with a 5% probability of mistake, i.e. when the value of p (the probability of error in rejecting the null hypothesis) fell below 0.05.

Results

In the monitored period (January 2017 to October 2019), a total of 100 patients were treated from the primary centre. MS was used in 31 patients, DS in 32 patients, and OT in 37 patients.

The demographic and basic characteristics of these patients are set out in Table 1. Analysed time intervals and treatment results are set out in Table 2.

Time to groin puncture and recanalisation among the DS, MS and OT patients showed statistically significant differences. There was no statistically significant difference between MS and OT in time to recanalisation, although there was a statistically significant difference in the time to groin puncture: 111 min for the MS, and 124 min for the OT.

There was a significant difference in door-to-groin time (DGT) for MS, which was significantly longer. This time is practically doubled during ambulance transports. In the case of OT and DS, there was no influence of institutional emergency service time on DGT. OT showed a halving of time to the start of IVT (depending on the departure of rescuers): 27 min *vs.* 63 min for MS and 50 min for DS.

Table 1. Patients' demographic and baseline clinical characteristics

Transport	DS	MS	OT	P-value
N (male, %)	31 (13, 41.9%)	32 (17, 53.1%)	37 (10, 27%)	0.085
Age (years, mean ± SD)	75. 6 ± 10.6	70. 5 ± 10	73. 5 ± 11.3	0.229
Hypertension (n, %)	30 (96.8%)	27 (84.4%)	30 (81.1%)	0.138
Diabetes mellitus (n, %)	12 (38.7%)	11 (34.4%)	15 (40.5%)	0.867
Ischaemic cardiopathy (n, %)	15 (48.4%)	11 (34.4%)	6 (16.2%)	0.017
Atrial fibrillation (n, %)	11 (35.5%)	10 (31.3%)	12 (32.4%)	0.934
Anticoagulation (n, %)	2 (6.5%)	4 (12.5%)	2 (5.4%)	0.517
Hyperlipidemia (n, %)	22 (71.0%)	19 (59.4%)	24 (64.9%)	0.628
Admission NIHSS (median ± SD)	18 ± 7	20 ± 5.7	17 ± 6.9	0.313
ASPECTS (median)	10	10	10	0.945
Transport time (minutes, mean ± SD)	73 ± 9.8	37.5 ± 14.1	71 ± 14	< 0.00001
Distance to CSC (kilometer, mean)	68	58	71	0.004
IES time (n, %)	20 (64.5%)	15 (46.9%)	21 (56.8%)	0.367
Wake-up + unknown time of origin	6 (19.4%)	4 (12.5%)	10 (27%)	0.321

ASPECTS — Alberta Programme Early CT Score; CSC — comprehensive stroke centre; DS — drip-and-ship; IES time — institutional emergency service time; MS — mothership; NIHSS — National Institute of Health Stroke Scale; OT — ongoing transport

The group of patients with MS showed significantly shorter average distance from the ambulance departure point to CSC. This was due to the inclusion of patients from one district who previously (at the time of this study, until 2018) fell under PSC Chomutov (Fig. 1). The district of Most was assigned to another primary PSC during 2018 as part of a reorganisation to improve the management of stroke in the region. This important aspect is reflected in Table 3, which shows a comparison of MS and OT without including these primarily transported patients in the CSC. These patients did not occur in the OT group because the territorial assignment to another PSC preceded the introduction of this type of transport for the PSC Chomutov.

Our results show that the average distance to CSC was not statistically significantly different, and that patients received IVT statistically significantly earlier. Time to groin puncture shows that the intervention initiated during MS working hours was faster by a few minutes, but exactly the opposite was true in terms of time of institutional emergency service. Institutional emergency service time in the Czech Republic consistently covers 77% of the year.

Discussion

Considering the time delay due to DS, MS is preferred when comparing the MS and DS concepts. Some recent data confirms a higher chance of a better clinical outcome in patients directly transported to MT [8]. Recently, Luchowski et al. [9] from a geographically close area, demonstrated a better clinical effect in MS compared to DS (when evaluating the achievement of mRS in the range 0–1).

However, some studies have not found a difference in clinical outcome between the two concepts [10, 11]. The concept of DS can be beneficial in areas where time availability is significantly different in favour of PSC rather than CSC [12].

However, in the Czech Republic this does not apply because of the high density of PSC and CSC networks.

Compared to MS, the advantage of DS can be earlier IVT administration only if logistically comparable care in PSC and CSC, in the form of comparable median door-to-needle time (DNT), is provided. In our case, the difference was not statistically significant because the DNT in PSC at time of DS preference was practically twofold that of the DNT in CSC. The indisputable advantage of DS transport as opposed to MS transport is that the CSC has information about the upcoming intervention, which is confirmed by the significantly shorter DGT, even at the time of institutional emergency service. At this time the angio team is not present in the hospital, and is activated from home after the diagnosis of LVO. For this reason, DGT significantly increases in MS during institutional emergency service. For DS, the team is activated while the patient is in the primary centre. So this is a logistical advantage for the centre, but not for the patient. The results of our study confirm that DS transport is significantly disadvantageous for the patient in respect of the total time required from ambulance departure to groin puncture, as well as in respect of the total recanalisation time.

However, the shorter time from ambulance departure to groin puncture is the only advantage of MS transport. The disadvantage of MS is a significant burden of CSC by unindicated patients including the need to stop the elective programme in the angio-room.

Our study shows that IVT was statistically significantly earlier administered with using OT from the PSC Chomutov area, both within the centre (DNT) and overall related to the ambulance departure from the interventional point. Unlike

Table 2. Results

	DS	MS	P	DS	OT	P-value	MS	OT	p
N	31	32		31	37		32	37	
ICH (n, %)	7 (22.6 %)	6 (18.8%)	0.707	7 (22.6 %)	7 (18.9%)	0.710	6 (18.8%)	7 (18.9%)	0.986
SICH (n, %)	1 (3.2 %)	1 (3.1%)	0.982	1 (3.2 %)	0	0.271	1 (3.1%)	0	0.279
IVT (n, %)	18 (58.1 %)	27 (84.4%)	0.021	18 (58.1%)	30 (81.1%)	0.038	27 (84.4%)	30 (81.1%)	0.719
DNT (min)	37	13	< 0.00001	37	11	< 0.00001	13	11	0.568
Time to IVT (minutes)	50	63	0.375	50	27	0.007	63	27	< 0.00001
Transport time (min, mean ± SD)	73 ± 9.8	37.5 ± 14.1	< 0.00001	73 ± 9.8	71 ± 14	1	37.5 ± 14.1	71 ± 14	< 0.00001
Distance to CSC (km, mean)	68	58	0.008	68	71	0.640	58	71	0.003
RT (median ± SD)	303.5 ± 59.8	221.5 ± 86.5	0.001	303.5 ± 59.8	255.5 ± 86.8	0.305	221.5 ± 86.5	255.5 ± 86.8	0.144
VRT (median ± SD)	237 ± 60	163 ± 42	< 0.00001	237 ± 60	168 ± 43	< 0.00001	163 ± 42	168 ± 43	0.692
DGT (min)	24	58.5	< 0.00001	24	23	0.340	58.5	23	< 0.00001
DGT in IES (min)	25	80	< 0.00001	25	23	0.127	80	23	< 0.00001
DGT in working hours (min)	23	39.5	0.032	23	22	0.348	39.5	22	0.00001
VGT (min)	185	111	< 0.00001	185	124	< 0.00001	111	124	0.003
Recanalisation (TICI 2b-3) (n, %)	25 (80.6%)	22 (68.8%)	0.278	25 (80.6%)	36 (97.3%)	0.024	22 (68.8%)	36 (97.3%)	0.001
mRS ≤ 2 at 90 days (n, %)	15 (48.4%)	14 (43.8%)	1	15 (48.4%)	17 (48.6%)	1	14 (43.8%)	17 (48.6%)	1
Mortality at 90 days (n, %)	12 (38.7%)	10 (31.3%)	0.535	12 (38.7%)	8 (21.6%)	0.124	10 (31.3%)	8 (21.6%)	0.364

CSC — comprehensive stroke centre; DGT — door-to-groin time; DNT — door-to-needle time; DS — drip-and-ship; ICH — intracerebral haemorrhage; IES time — institutional emergency service time; IVT — intravenous thrombolysis; mRS — modified Rankin Scale; MS — mothership; OT — ongoing transport; RT — time to recanalisation; SICH — symptomatic intracerebral haemorrhage; TICI — Thrombolysis in Cerebral Infarction Scale; Time to IVT — time to IVT from ambulance departure at point of intervention; VGT — time to groin puncture from ambulance departure at point of intervention; VRT — time to virtual recanalisation from ambulance departure at point of intervention

Table 3. Results without the district of Most

	MS	OT	P-value
N	15	37	
Distance to CSC (km, mean)	74	71	0.777
Transport time (min, mean ± SD)	67 ± 10.4	71 ± 14	0.026
Time to recanalisation (median ± SD)	220.5 ± 74.1	255.5 ± 86.8	0.161
Time to virtual recanalisation (median ± SD)	165 ± 32	168 ± 43	0.597
DGT (min)	49	23	< 0.00001
DGT in IES (min)	70	23	0.0002
DGT in working hours (min)	44.5	22	0.0002
VGT (min)	117	124	0.127
VGT in IES (min)	133	123	0.398
VGT in working hours (min)	107.5	125	0.012
Time to IVT (minute)	72.5	27	< 0.00001
Recanalisation (TICI 2b-3) (n, %)	11 (73.3%)	36 (97.3%)	0.034
mRS ≤ 2 at 90 days (n, %)	5 (33.3%)	17 (48.6%)	0.571
Mortality at 90 days (n, %)	5 (33.3%)	8 (21.6%)	0.696

CSC — comprehensive stroke centre; DGT — door-to-groin time; DNT — door-to-needle time; DS — drip-and-ship; IES time — institutional emergency service time; IVT — intravenous thrombolysis; mRS — modified Rankin Scale; MS — mothership; OT — ongoing transport; TICI — Thrombolysis in Cerebral Infarction Scale; Time to IVT — time to IVT from ambulance departure at point of intervention; Time to virtual recanalisation — time to recanalisation from ambulance departure at point of intervention, VGT — time to groin puncture from ambulance departure at point of intervention

the DS, having an emergency crew on hand is a very important motivating factor for shortening DNT within the PSC. According to information from the PSC, a side effect of the introduction of OT due to the necessary change in logistics was a year-on-year decrease in DNT (from all IVTs filed at the workplace) from 28.5 min (Q1 2018) to 15 min (Q1 2019). After lowering the DNT, the Door In-Door Out (DiDo) time in the PSC was 20 min, which is acceptable for the waiting EMS crew (if endovascular performance is not indicated, the EMS can leave after 10 min — which is acceptable in all cases including stroke mimics).

In our study, we found a correlate of DNT in PSC only in patients with LVO at the time of preference for DS (37 min) *vs.* DNT for OT (11 min). Patients with OT had a statistically significant earlier IVT (27 min relative to virtual departure time) *vs.* MS (63 min). With the growing difference between arrival time to the PSC and the CSC and ambulance departure from the place of intervention, the difference in the starting time of IVT also increased proportionately.

In the case of OT, the angio-team was informed in advance and there was no statistically significant difference in the care from arrival to the CSC *vs.* DS — correlate is represented by comparable DGT in CSC independent of working hours or hours during institutional emergency service. The total recanalisation time did not differ significantly between MS and OT, but it is influenced by more independent factors (the necessity for general anaesthesia, duration of MT, recanalisation). Therefore, we focused on the time to groin puncture. According to our results, time from ambulance departure in the place of intervention (VGT) to groin puncture differed statistically significantly, even in the absence of typical delay for DS, but in absolute values the time difference was only 13 min — 111 min for MS *vs.* 124 min for OT.

A critical look at the data reveals a significant difference in the distance between the place of ambulance departure and CSC, namely 58 km for MS and 71 km for OT. As shown in Figure 1, this is due to the inclusion of one district located between the PSC and the CSC and this district logically benefits from a primary transport to the CSC (eventually after reorganisation of care from OT via an alternative PSC). If we omit this district, as shown in Table 3, the distance from the CSC does not differ significantly (74 *vs.* 71 km). There was an even less significant difference in terms of VGT: 117 min for MS and 124 min for OT. During working hours, a greater difference was seen (107.5 min *vs.* 124 min) in favour of MS, but during institutional emergency service time the situation was reversed: 125 min *vs.* 133 min in favour of OT. Working hours in the Czech Republic have been stable over the long term at the level of 23% of the year. In other words, purely in terms of the groin puncture time, MS for 23% of the year seems to be one minute more favourable, and OT for the other 77% of the time.

There are many independent factors which can affect a patient's clinical outcome after MT, and the type of transport can be one of them. The highest mortality, although statistically insignificant, was seen in DS (38.7%), followed by MS (31.3%), and the lowest mortality was in OT (21.6%). There was not a statistically significant difference even in clinical outcome between transport modes, which was not surprising. In our study, we analysed patients who had undergone MT. However, the chosen mode of transport generated additional groups of patients who were initially indicated for MT, but this was not

directly related to the mode of transport and these patients were not included in the study. In DS, some patients indicated for MT in PSC, after reaching CSC, MT was no longer indicated for MT because of the control CT image (the extent of ischaemia) in CSC — the PSC's patient failed to arrive on time.

Some patients are recanalised by IVT (the chance of recanalising a large artery by IVT is reported as being 16–30% [13–15]) and the patient arrives 'graphically cured' from PSC. In some patients, the embolism was dislocated beyond the reach of endovascular intervention and these patients also did not undergo MT. OT generates the same patient groups — the chance of IVT recanalisation is the same, but the probability that the indicated patient will not arrive on time is significantly less due to the absence of a significant time delay. MS is unambiguous from this point of view — the patient is or is not indicated to MT according to the initial examination in CSC. How a particular case would unfold in the case of administration via PSC is purely speculative. In our case, from 2015 to the launch of the OT programme in April 2018, 18 primarily indicated patients did not manage to arrive on time (DS) from PSC Chomutov to the CSC for the realisation of MT. Since the launch of the programme until now (March 2020), there have only been two patients — one was exceptionally transported by DS for technical reasons and one case (OT) was already borderline in PSC (ASPECT6).

OT, by its characteristics, eliminates the disadvantages of DS and MS and brings together all the advantages of these concepts. It gives a chance to all indicated patients for the performance of MT, the CSC is not overloaded with patients, and IVT can be administered significantly earlier. Individual characteristics are differently accentuated by distance between cooperating centres. When we assess the impact of the type of transport, it is necessary to pay close attention to the geographical and transport characteristics of the region and to eliminate as much interference as possible on time characteristics. As shown in the example of one district, it is necessary to take into account the distance between the PSC and CSC. These aspects significantly limit the possibilities of a multicentre study. The concept of OT is significantly more demanding in terms of cooperation between centres and emergency crews, which is not necessarily a disadvantage.

Conclusions

OT is a safe and convenient alternative to MS and DS of a stroke patient when a large artery is occluded to MT. It combines all the advantages, and eliminates all the disadvantages, of all known concepts.

Necessary logistical changes significantly reduce DNT even in patients with AIS and even those without indication for MT.

The OT concept gives all indicated patients a chance for MT to be performed and there is no overload of the performing centre.

According to the results of our study, patients received IVT (related to ambulance departure from the place of intervention) significantly earlier.

At times of institutional emergency service (i.e. for 77% of the year), OT is more advantageous than MS in terms of time to groin puncture.

During working hours, the situation is more complicated when patients receive IVT significantly earlier, but groin puncture is delayed by several minutes (units of minutes). With regard to this minimal difference, we still prefer OT even during working hours, with an emphasis on the application of further logistical steps to speed up transport by the necessary units of minutes.

Ethical permission: *The study protocol complied with the Helsinki Declaration (1975) and was approved by the Ethics Committee.*

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Conflicts of interest: *None.*

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