

## Mechanical thrombectomy for ischemic stroke

### A role for cardiology!

**To the editor** Acute ischemic stroke (AIS) is a major cause of death and disability. Up to approximately 35% strokes are caused by potentially reversible large-vessel occlusion (LVO). The recent stroke thrombectomy clinical vignette in *Kardiologia Polska (Kardiol Pol, Polish Heart Journal)*<sup>1</sup> presents a major stroke patient who, in all likelihood, would have been a routine candidate for guideline-mandated<sup>2</sup> mechanical thrombectomy (MT) to improve his life-long prognosis by reducing the discharge disability level.<sup>2</sup> Although a full functional recovery can never be guaranteed, imaging studies portended a significant opportunity for major improvement with MT which could have restored functionality and saved the long-term care burden and health system costs.

Time to intervention is critical in LVO-AIS, with patients revascularized in 2 hours or less achieving approximately 90% good functional clinical recovery.<sup>2</sup> The recovery associated with a delay of more than 6 hours is considerably poorer, yielding approximately 20% good functional outcome.<sup>2</sup> Despite the on-site availability of a staffed primary percutaneous coronary intervention catheterization laboratory used for elective neuroradiology procedures, a certified AIS-MT operator (cardiologist/angiologist) and what appears to be an upstanding stroke unit (catchment area of approximately 500 000 inhabitants, stroke thrombolysis leading implementation), MT was regrettably not performed on site.<sup>1</sup>

Referral was mandated to the single “designated” MT center (comprehensive stroke centre, CSC) in the region (province) inhabited by a large population (3.8 million) with transfer times of up to approximately 3 hours. Stroke epidemiology data suggest this region needs up to 1500 MTs per year. No routine CSC is able to process more than 250 to 300 MT cases per year. The data-driven goal is revascularization within 2 hours for best results.<sup>2</sup> No avoidable transportations can be accepted in AIS.

This patient was rejected by CSC citing “negative effect of transportation on MT eligibility.”<sup>1</sup>

The classic (6 hours)<sup>2</sup> window would have been borderline at the CSC<sup>1</sup> while rich collaterals<sup>1</sup> indicated, in fact, an extended window.<sup>2</sup> He was ineligible for thrombolysis (whose efficacy is significantly limited in LVO), was refused MT in the CSC, and unsurprisingly, had a very bad outcome (Modified Rankin Scale score, 4) and will be a burden to his family and the health system. This all could likely have been avoided by rapid MT at a local facility.

The story<sup>1</sup> illustrates several issues fundamental to understanding current problems with MT adoption, including a rapid and effective access to MT as the first-line consideration. Indeed, with the current very poor access to MT in some countries including Poland,<sup>3</sup> stroke interventions must be rapidly expanded geographically and with a dramatic increase in the number of willing and trained interventionists to meet the enormous public health need.

The “gold standard” treatment of AIS (rapid mechanical revascularization) mirrors the last 2 decades of acute myocardial infarction care. In contrast to acute myocardial infarction, however, we now face an overwhelming shortage of neurointerventionists to support the shift in AIS treatment. Therefore, interventionists from other training backgrounds must now fill this gap in AIS, and a collaborative ST-segment elevation myocardial infarction (STEMI) model for care needs to be instituted to ensure rapid revascularization, particularly as the brain cells are far more sensitive to ischemia than the myocardium.<sup>4</sup> If the case is very complex, the time to transfer the patient from a thrombectomy-capable centre to CSC is *after* the blocked artery has been opened and the brain reperfused. Otherwise, local treatment will suffice.

Training many more neuroradiologists does not appear to be a practical solution. The volume of elective intracranial work does not provide enough cases to support the many more providers needed to treat AIS. The only practical solution is to recruit and train other practicing interventionists, such as cardiologists and interventional radiologists (neurologists

willing to take the interventional track are also welcomed, though the training path for those without prior exposure is longer), to perform the time-sensitive revascularization at the location closest to AIS onset.<sup>4</sup> For this approach to work, these physicians need cognitive preparation as well as hands-on experience, while MT procedures performed on simulators (similar to the training of airline pilots) may play a particularly important role. Interventional cardiologists (ICs) appear well suited to take on this task. They are accustomed to 24/7/365 STEMI coverage and are highly skilled at reopening occluded arteries—something neurointerventionists rarely do outside of AIS treatment. ICs techniques and goals (opening stenosed/occluded arteries) are similar to those required for stroke intervention.<sup>4</sup>

Some cardiologists possess a particularly important additional advantage, that is, their experience in supra-aortic vessel cannulation and carotid artery stenting, which may greatly reduce their training path to safe and effective MTs. Training of ICs (and other endovascular specialists such as interventional radiologists or endovascular-skilled vascular surgeons) should be individualized but meet a well-defined bar,<sup>1</sup> and it should be based on the cardiologist's interest, experience, skill set, local multidisciplinary capabilities, and institutional commitment to collaboration.<sup>4</sup> On-site neurosurgery is not required in thrombectomy-capable centres.<sup>2</sup> A significant body of evidence shows that stroke intervention can be performed safely, successfully, and efficiently by appropriately trained physicians from different specialties who are skilled in navigating and opening small arteries.

Poland must now adopt in routine MT practice its unified MT training requirements<sup>1</sup> for cardiologists, angiologists, neurologists with an interest in vascular interventions, and vascular surgeons with neuroendovascular skills that had been defined through a multi-specialty consensus.<sup>1</sup>

In conclusion, the STEMI model perfected by cardiologists over the last decades works well, saves lives and money, and is an excellent standard for successful AIS care. Recent publications demonstrate that well-trained teams of ICs and stroke physicians can replicate the superb results of recent randomized trials in optimizing care for LVO stroke.<sup>5</sup>

A new paradigm is needed to optimize outcome for AIS caused by LVO. Patients should be treated at the nearest neuro-angiographic suite or cardiac catheterization laboratory to minimize delay. Multidisciplinary stroke teams must be organized like STEMI teams. In rural cardiac centers, straightforward cases can be managed with good results by local teams pairing cardiologists and neurologists, with only complex cases transferred to CSCs. Quality of

care at the current CSCs and the new centers (guideline-indicated<sup>2</sup> thrombectomy-capable centers) needs to be systematically assessed, with feedback used to improve further.

Turf (territorial “protection”) issues must not be allowed to interfere with the benefits for an individual patient and public health. Prohibition of collaboration<sup>1,5</sup> and/or excessive requirements designed to protect turf are not acceptable.<sup>4,5</sup>

## ARTICLE INFORMATION

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## Multispecialty team training in stroke mechanical thrombectomy to optimize thrombectomy deliverability

**To the editor** In the April issue of *Kardiologia Polska (Kardiol Pol, Polish Heart Journal)*, Musiałek et al<sup>1</sup> raised a question fundamental to many healthcare systems today: where and how to best treat patients presenting with large-vessel occlusion (LVO) acute ischemic stroke within the time window for mechanical thrombectomy (MT).

The index hospital in the recent stroke thrombectomy clinical vignette<sup>1</sup> serves a population of approximately 500 000 individuals. It belongs to the leaders in adoption of stroke thrombolysis, indicating good both stroke and patient management pathways. The hospital runs a primary percutaneous coronary intervention service on a 24/7/365 basis. There is no on-site neuroradiology, but the cardiac catheterization laboratory is equipped in line with neuroradiology standards,

and elective neuroradiology procedures are performed several times a year. The nearest comprehensive stroke center (CSC) is located at a travel distance of at least 1.5 hours, meaning a practical delay of at least 2 hours until the patient can be brought to the table.

As a professor of radiology, interventional radiology, and neuroradiology, with many years of experience in acute stroke interventions, I would like to draw attention to some points that put the recent stroke thrombectomy clinical vignette<sup>1</sup> in a perspective that may be important to the readers of *Kardiologia Polska*.

In the Western world, ischemic stroke is the main cause of disability. Infarction of cerebral tissue can be prevented when brain perfusion is restored before the cells have definitively died. The normal perfusion rate is between 50 and 60 ml of blood per minute per 100 g of tissue. At a perfusion rate of about 20 ml of blood per minute per 100 g of brain tissue, the cells stop functioning, but the flow is still sufficient for structural metabolism. When the flow rate drops to 12 ml of blood per minute per 100 g of brain tissue, the cells will die. This process of neuronal death is time dependent.

Older trials showed that intravenous thrombolysis can, in some instances, dissolve the thrombus in the blocked cerebral artery, but, in the case of LVO, the efficacy of thrombolysis is limited. Thrombolysis efficacy is further hampered by the large clot size (particularly if it is above 6 mm) and the clot age/structure ("old," organized clots are poorly amenable to thrombolysis). Thus, for more than 10 years, stroke centers have switched to routine MT in large artery occlusions such as those affecting the carotid, basilar, and central cerebral arteries. Five randomized controlled trials published in 2015 convincingly demonstrated much better clinical outcomes with thrombectomy (on top of thrombolysis) than with thrombolysis alone.<sup>2</sup> There is no doubt today that MT performed in a timely manner saves patients from permanent disability (with less than 3 patients needed to treat to prevent 1 case of severe disability).<sup>2</sup> In addition, recent meta-analyses have indicated that MT also saves lives (1 life gained for every 31 patients treated).<sup>3</sup> Importantly, mortality reduced by MT is not linked to any increased likelihood of functional disability but, rather, MT improves functional outcomes.<sup>3</sup>

Stroke physiology and the analysis of MT outcomes<sup>2</sup> show that a 2-hour transport for MT<sup>1</sup> is associated (a priori) with a systematic failure to perform the procedure within the golden time window for MT, particularly in early presenters. Indeed, MT, if performed within 2 hours from stroke onset, is associated with a 90% likelihood of a favorable functional recovery. After that, the statistical benefit drops markedly.<sup>2</sup> Thus, the transportation time systematically translates, without any doubt, into statistically worse clinical outcomes.<sup>2</sup>

Another important fact arising from the communication by Musialek et al<sup>1</sup> is the issue of stroke MT center "saturation." A single MT center (currently the CSC)<sup>1</sup> is very unlikely to be able to provide an effective stroke service to a population of 3.4 million individuals.<sup>1</sup> This is because, in such a scenario, the yearly MT load would be at the level of at least 500 to 600 cases, with many more patients requiring admission and logistic processing (including imaging and workup).

From the description provided,<sup>1</sup> the index hospital fits, in general, into the guideline definition of a thrombectomy-capable stroke center (TCSC), provided there is staff capable of performing MT. The question raised by the authors<sup>1</sup> as to "how" to (best) treat the patient includes, to me, the background issue of "who"... "can" and "should" (or maybe just "is able to"?) deliver MT to the patient on-site. This question is crucial.

Today, in most countries in the world, the availability of experienced interventional neuroradiologists who can perform MT is limited, translating into a low (in some countries—an alarmingly low) proportion of patients with LVO stroke who receive the brain- and often life-saving intervention.<sup>4</sup> Thus, in 2015, we founded the World Federation for Interventional Stroke Treatment (WIST) to train vascular interventionists, such as angiologists, cardiologists, interventional radiologists, endovascular-skilled vascular surgeons, or those neurologists who wish to enter the endovascular operator path, to perform cerebral artery thrombectomy. Curriculum-based (but tailored to the different teams' baseline knowledge, skills, and needs) training includes clinical stroke signs, imaging of the brain and cerebral arteries, carotid angioplasty and stenting, and cerebral artery thrombectomy, as well as organization of the stroke center. In the last 5 years, groups of interventionists coming from different specialties and from stroke centers located on different continents have been certified by the WIST. Most of them are today active in their TCSC teams and importantly contribute to making MT accessible to their patients and healthcare systems.

We hope that the number of disabling strokes, as in the described patient,<sup>1</sup> can be significantly reduced in the near future, when the service is offered in more hospitals, translating into shorter transportation times and, thus, a reduction in the magnitude of irreversible brain injury. Establishing more MT centers is cost-effective not only for individual patients but also for healthcare systems.<sup>5</sup> Indeed, neurorehabilitation and lifelong external care of a disabled person is much more expensive than the stroke intervention and the hospital stay.<sup>5</sup> The public deserves information on evidence-based management of LVO ischemic stroke including stressing the paramount importance of the time issue in acute ischemic stroke.

## ARTICLE INFORMATION

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## "Time is brain" is a no-brainer

**To the editor** Stroke is among the most dreaded events. Some might consider major mental and physical disability ensuing from a stroke as worse than death. The consequences are detrimental not only for the patient but also for the families, healthcare system, and society.

For decades, medical therapy had been the treatment of choice. For ischemic stroke, intravenous fibrinolysis is recommended if the patient arrives within a time window of a 4.5 hours in absence of contraindications to the lytic therapy. Unfortunately, in large vessel occlusions that are responsible for the most devastating forms of ischemic stroke, the efficacy of lytic therapy is very limited.

It is precisely this situation in which several randomized trials have demonstrated that mechanical thrombectomy in addition to systemic fibrinolytic therapy is superior to fibrinolytic therapy alone. There is no other interventional cardiovascular therapy today that has been so convincingly demonstrated to improve functional outcome in such a dramatic fashion.

Rapid initiation of endovascular treatment is paramount to success. The time between the onset of symptoms and vessel recanalization is the most important predictor of a good clinical outcome. Unfortunately, in most regions of the world, the number of neuro-interventional centers and/or neuro-interventional specialists is insufficient to provide transcatheter

embolectomy in a timely manner while patient transfer to a tertiary comprehensive stroke center is often associated with time delays that make the difference between a favorable functional recovery and severe disability.

The clinical vignette presented in this journal by Musialek et al<sup>1</sup> clearly illustrates the problem that, from the statistics provided, is relevant to the fate of many hundreds of stroke patients in the country. A 69-year-old man with a major stroke arrived on a Sunday night in a large regional hospital within a time window that would make him suitable for transcatheter embolectomy. The cardiologist on call had been trained and certified in acute stroke interventions by the World Federation for Interventional Stroke Treatment (WIST) but could not perform the intervention. The patient was not accepted by the nearest comprehensive stroke center due to anticipated effect of the transport delay (1.5–2 hours) on thrombectomy eligibility (the expected patient arrival to the comprehensive stroke center was some 5–6 hours from the stroke onset). This occurred despite the fact that the rich collateral circulation suggested that the patient could benefit from embolectomy even beyond the usual 6-hour window, with a statistical cerebral and clinical benefit fundamentally smaller than that in case of an on-site immediate treatment but still fundamentally larger than in case of no intervention at all.

There are dire consequences due to our medical systems lacking the foresight and flexibility to recognize the potential of effective and safe mechanical thrombectomy by endovascular operators of various specialties including interventional cardiologists. In far too many cases this results in a dependency on life-long nursing care or death. This is not inevitable. Rather, it is completely avoidable and, therefore, unacceptable.

Interventional cardiologists can provide not only fully operational infrastructure that offers 24/7/365 interventional therapy for patients with acute myocardial infarction but also the mindset for an immediate intervention during the weekend and in the middle of the night and skills in carotid and other interventions beyond the coronary tree. Indeed, numerous recent publications from several countries on 4 continents (only some of which can be referenced below) clearly demonstrate that cardiologists are able to perform intracranial thrombectomy with results similar to those in pivotal randomized trials.<sup>2-5</sup>

The merit of mechanical thrombectomy is undisputed. It is now time to enforce health care systems modifications that will enable every eligible person to benefit from this treatment regardless of location. Analogous to primary percutaneous intervention in acute myocardial infarction, mechanical thrombectomy must occur regionally, including cardiology cathlab-based

thrombectomy-capable centers collaborating with local stroke units,<sup>2-5</sup> without delay rather than being limited to sparse large (comprehensive) stroke centers run mostly by neuro-radiology. To achieve this, it is less important to focus on the specialty of the endovascular operator, but on how to provide the necessary training in a reasonable and timely manner. We congratulate our Polish colleagues on clearly defining, through a multi-specialty consensus under the auspices of their Ministry of Health, stroke thrombectomy unified training requirements that are similar irrespective of the operator “basic” specialty—angiology, neurology, endovascular surgery, or cardiology.<sup>1</sup> This is a model achievement on the map of turf wars that are regrettably continued in some places in the world at the price of human brains and lives. “Time is brain” not only means that we must open the culprit vessel as quickly as possible but, equally importantly, that a routine access to this therapy must be created quickly and safely.

#### ARTICLE INFORMATION

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#### Why is it still a gleam in people's eyes in Poland?

**To the editor** Mechanical thrombectomy has become the standard of care for acute ischemic stroke with proximal large vessel occlusions. Despite this accepted knowledge, in the April issue

of *Kardiologia Polska (Kardiol Pol, Polish Heart Journal)* Musiałek et al<sup>1</sup> presented a clinical vignette of a 69-year-old man with acute ischemic stroke and with contraindication to thrombolysis who, however, was not treated with mechanical thrombectomy in a timely fashion. The reason for this was the refusal from a single available regional stroke center due to anticipated excessively long transportation time from a local hospital where the patient was diagnosed with the use of computed tomography. Then, the patient was treated conservatively in a local hospital, and 2 months after the acute episode, he was still severely disabled and unable to live without external care. We all should agree that this exemplifies a distressful failure of the stroke-care system in Poland.

There are 2 most important questions arising from that article: 1) how many regional stroke centers do we need in Poland to diagnose and treat patients with ischemic stroke? and 2) who can perform manual thrombectomy? To address the first one, we should base the answer on the interventional cardiology experience we had so far—a network of the catheterization laboratories working 24 hours a day, 7 days a week to treat patients with acute myocardial infarction (AMI). The optimal number of individuals served by one interventional cardiology unit to offer appropriate service for patients with AMI is not precisely determined in guidelines, but in Poland it is 200 000 to 250 000. The time from onset of AMI symptoms to primary percutaneous coronary intervention should not exceed 120 minutes. A longer delay is not acceptable and these patients should be treated by thrombolysis and then transferred to a catheterization laboratory for coronary angiography. In Poland, because of a very dense public and nonpublic catheterization laboratory network (over 150 units), thrombolysis for treatment of AMI practically does not exist. Do we need the same number of thrombectomy units for the treatment of ischemic stroke? Even if probably much less would be the optimal number, we have to remember that the acceptable time window for treatment of ischemic stroke should not optimally exceed 6 hours (with extension to 24 hours in selected cases; however, the concept of “time is brain” remains critical). The patient described was within the window for mechanical thrombectomy if treated on-site and on the verge of the 6-hour window if transported to the nearest comprehensive stroke centre, though with the magnitude of collateral circulation he was likely to belong to the extended window cohort.<sup>2,3</sup> And not in every case of stroke, as well as in every case of AMI, thrombolysis is desirable. Taking into consideration the very unfortunate clinical course of the example described by Musiałek et al,<sup>1</sup> I can conclude that the number of mechanical

thrombectomy centers in Poland should be increased to provide full-time service to all patients with ischemic stroke, and that the optimal number of centers should be primarily based on the experience of other countries with a more advanced system of the management of patients with ischemic stroke.

The answer to the second question is even more difficult. Neurologists as well as interventionalists: neuroradiologists, neurosurgeons, vascular surgeons, angiologists, and cardiologist are the major players in the field of mechanical thrombectomy for ischemic stroke. All these specialists are included in the regulation of the Ministry of Health issued in 2018 on the pilot program for the treatment of ischemic stroke in Poland with the use of mechanical thrombectomy similar to regulations in many other countries in the world.<sup>4</sup> The appropriate training of operators is a cornerstone requirement and then the interventional treatment may be performed in a hospital with neurology department with access to computed tomography or magnetic resonance imaging on site, interventional radiological laboratory or cardiac catheterization laboratory, and with the access to neurosurgery with transportation time within 30 minutes. According to these criteria, the pilot project could be accomplished in a quite reasonable number of large multidisciplinary hospitals in Poland, and the network should assure easy access of every patient with ischemic stroke within predefined time frames to intervention. A multidisciplinary team for initial patients' assessment and treatment as well as certification of stroke centers by an independent external body is also recommended. Also, outcomes for all patients should be tracked.<sup>5</sup> Unfortunately, this well-designed but still imaginary concept did not work in the discussed case. The almost perfect interventional treatment of AMI has not yet been adopted into ischemic stroke management by the healthcare system in Poland that needs to include thrombectomy-capable centres along the sparse comprehensive stroke centres.<sup>5</sup> There are multiple diverse reasons for such a situation, which are well known from other European countries and the United States, including: 1) the divergent interests of major players in the field; 2) no acceptance for catheterization laboratories and interventional cardiologists as sites and operators for stroke interventions among other medical specialists, despite the Ministry of Health regulation; 3) few training centers and established formal training programs; and 4) insufficient funding from public resources to develop a dense network for acute stroke interventions. This is also a bad example of mutual resentments which are obviously not patient oriented and should always be avoided—but they are not. This deplorable case of abandonment of optimal treatment is a very serious

argument for real contribution of all parts interested in the ischemic stroke interventions, including also cardiologists, and incorporation of an effective network of catheterization laboratories located in big multidisciplinary hospitals within the new system of acute stroke management. There is no time to waste if we want to stop preventable stroke disability in Poland.

## ARTICLE INFORMATION

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## Deceptive access promoted by leading neurologists harms patients

**To the editor** The case described by Musiałek et al<sup>1</sup> in the April issue of *Kardiologia Polska (Kardiol Pol, Polish Heart Journal)* shows ineffective treatment of a patient with stroke. It illustrates the incorrect, from the public health standpoint, implementation of new technology. Thrombolytic therapy helps to dissolve the clot clogging the vessel and improves blood flow in 25% of the patients with ischemic stroke. However, intracranial bleeding is not a rare complication. Statistical data confirm that early thrombolysis is beneficial for the population, but it is rather a gambling game for an individual patient. Some neurologists, fascinated by the results of clinical trials, promote thrombolysis, while others, mainly caring for patients in practice, are more restrained in offering treatment that relatively often transforms mild ischemic stroke into large hemorrhagic stroke. After many years of promotion, thrombolysis is still far from widespread

use. Recently, a new breakthrough technology has become available—a mechanical retriever of a clot from the occluded vessel (mechanical thrombectomy [MT]). Compared with thrombolysis, it is much more effective and causes fewer complications.<sup>2</sup> However, it has a disadvantage: it cannot be used by neurologists in stroke centers.

Musiałek et al<sup>1</sup> described the case of a patient who was qualified for transfer to a neuro-radiological center (comprehensive stroke center [CSC]) after the diagnosis of middle cerebral artery blockage and finding contraindications for thrombolysis. However, the CSC refused to admit the patient arguing that it would be “too late for treatment.” Was it necessary to waste time in a local hospital? The scheme of care for the patient with stroke in Poland requires “thrombolysis first” and only if there is no clinical improvement, transfer for endovascular treatment is suggested. This usually causes a much longer delay than in the case of contraindications for lysis. Time-consuming transport and ineffective alteplase usually move patients out of the time window for MT treatment. Every minute counts for saving the brain, so the obvious rule should be “most effective treatment first.” There is strong scientific evidence that the benefit of MT is greater than that of fibrinolysis,<sup>3</sup> except when MT is associated with significant waiting time for the procedure. This means that an ambulance should directly go to MT centers from most parts of the country. It is necessary to identify areas away from MT centers, from which transfer to a local stroke unit for thrombolysis could be an appropriate option.<sup>4</sup>

Certain relevant details of the case described by Musiałek et al<sup>1</sup> should be noted. The patient was referred to the CSC on Sunday, late at night. It is reasonable to doubt whether the reason for refusal was the time window for MT treatment or rather lack of readiness for midnight catheterization. The center needs an experienced interventionist ready to work 24/7/365 on-site. It means that 4 to 5 operators should be engaged. To overcome the shortage of interventionists, some centers organize them on-call instead of on-site. Probably, this was the real reason for refusal. Problems with availability of operators on duty easily explain what happened in that case.

The idea to carry out MT exclusively in neuroradiological CSCs has 3 main disadvantages. First, neuroradiological procedures for aneurysms and malformations are not so common and it is not economically reasonable to keep CSCs on 24/7/365 duty. Even the addition of the currently small number of patients requiring MT will not make these centers economically efficient. Second, CSCs have few interventionists, usually 1 or 2—too few to arrange 24-hour on-site service. Third, there is a small number of CSCs, so it is not possible to provide MT in suitable, short time in patients from most areas of

the country. This problem could be solved if decision makers were ready to think openly.<sup>5</sup> We have more than 150 cardiac centers performing coronary interventions with teams working on-site 24/7/365. They have a sufficient number of very experienced interventionists. If one-third of them became additionally MT centers, we could cure the current illogical and unethical system, which violates the main Hippocratic principle: “first do no harm.”

## ARTICLE INFORMATION

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## Interventional cardiology fills the fundamental gap in the system

**To the editor** In a recent clinical vignette,<sup>1</sup> a case of a 69 year-old man with up to 4 hours from the onset of acute ischemic stroke (AIS) was described. It represents a typical patient with a routine indication for mechanical thrombectomy (MT). Emergency medical services transferred the patient without delay to a large regional hospital, stroke diagnosis was unquestionable, plain computed tomography excluded bleeding, the ASPECTS score was a favorable 8, and computed tomography-angiography confirmed occlusion of the M1 segment of the right middle cerebral artery.<sup>1</sup> On-site (a definite first-line) or upon-transfer (second-line) MT should have been delivered without any hesitation as per current medical knowledge and guidelines.

The presented failure of a timely and effective delivery of stroke thrombectomy in Poland<sup>2</sup> is

remarkably similar to the situation in our country, Argentina until recently. The hospital,<sup>1</sup> despite being one of the national leaders in stroke thrombolysis with a significant catchment area, does not yet seem to have an operational MT service, despite a full 24/7/365 primary percutaneous coronary intervention service in a catheterization laboratory used for elective neuroradiology procedures. On-site immediate treatment would have been associated with the best discharge disposition.<sup>3</sup> The patient<sup>1</sup> with rich cerebral collaterals<sup>1,4</sup> would have also likely benefited from MT in the comprehensive stroke centre (CSC) located approximately 1.5 to 2 hours away; not only at his borderline<sup>1</sup> classic MT window (6 hours) but also, as shown in 2 major clinical trials, in an extended window.

Routine 1.5-to-2-hour referrals for MTs to a distant CSC<sup>1</sup> result in irreversible neuron losses during transportation (2 million cells per minute; unnecessary loss of 180–240 million cells, plus further losses related with the logistics at the receiving center and time spent on “own” patient workup with frequent reimaging). Avoidable transfers to distant center(s) have a major negative effect not only on the individual patient disability level<sup>3</sup> but also, equally importantly, on the proportion of patients with AIS who receive the guideline-mandated treatment. For a number of reasons, some eligible (or borderline eligible) patients<sup>3</sup> do not get externally referred, whereas others become ineligible for MT during transportation or pre-MT work-up.<sup>3</sup>

It thus lacks rationale that a large general hospital, already providing stroke services along elective neuroradiology procedures, with an appropriate setup for MT and a catheterization laboratory staffed and active 24/7/365, would not provide on-site MT but instead would lose time, money (and—most importantly—patients’ brains!) on routine 1.5-to-2-hours interhospital transfers, eliciting treatment delays killing the MT golden window of 2 hours, and increasing the disability level.

With the increasing worldwide demand for a fast MT resulting from MT trials success, there are not enough interventional neuroradiologists to cover the need. The current body of evidence is undisputable in that interventional cardiologists (ICs) achieve routine MT results not different from those in neuroradiology centers. This is particularly relevant as 24/7/365 emergency cardiac catheterization laboratory services are nationally widely-established, and the teams are experienced in urgent endovascular interventions. In addition, ICs can directly address any coexistent coronary disease.

With the magnitude and severity of the current MT problem in Poland,<sup>2</sup> the recent initiation of on-site cardiology catheterization laboratory services for stroke is encouraging,<sup>5</sup> but it is unclear why this is not yet a systemic solution.

Involving ICs in acute stroke care is a logical verified-in-practice solution to address the current public health urgency.

I live and work in the southwest of the Buenos Aires province in Argentina. I am an IC coordinating Stroke Thrombectomy Program in a consortium of 3 hospitals providing services to approximately 400 000 people.

In 2017, our 39-year-old nurse had a disabling stroke. Despite her being transferred to our emergency department without delay with a typical large vessel occlusion, she did not receive MT in the CSC she was referred to because of the transportation-inflicted delay and the time spent on repeating her imaging studies. She was discharged severely disabled (modified Rankin Scale score, 4). She has an extremely poor quality of life, requires daily physiotherapy and repeated hospitalizations for stroke consequences, and remains totally dependent on her family. Rather than actively contributing to treating stroke patients in our catheterization laboratory today, she is a burden to herself, her loving family, and the society.

It was then that we decided to set up AIS care in our region, and searched for certified training in MT. In 2018, I attended the ICCA STROKE Congress ([www.iccaonline.org](http://www.iccaonline.org)) held in the Institute of Neurology in Warsaw. After I passed an interview with Professors Iris Grunwald, Horst Sievert, and Klaus Mathias, who assessed my background knowledge and experience, I was admitted into the AIS training program by the World Federation for Interventional Stroke Treatments (WIST). I completed a neuroradiologists-run intensive 1-month theoretical and practical training course in the United Kingdom. It involved advanced hands-on training on simulators and in the neuroradiology laboratory. Each simulated procedure started with a clinical story by a referring physician on the phone, with me having to ask the relevant questions and make a decision whether the “patient” is to be accepted. It finished with a feedback from my neuroradiology mentor on my timing and the number of errors, and we discussed the mistakes to improve the skills. WIST then gave me some very practical guidance on how to setup our AIS service, specifically tailored to our local conditions and circumstances. This, without any doubt, was the key to a successful transition to MT in our catheterization laboratory. Finally, Professor Grunwald came to our hospital to support our first MTs, to help with service implementation, pathway optimization, proctoring and training key stroke team members from different specialties including neurology, anesthesia, and radiology/imaging. After that, WIST neuroradiology consultants have been available, via telemedicine, on an ad hoc basis.

In our multidisciplinary team, ICs performing MT are working hand in hand with stroke neurologists and diagnostic radiologists. We give patients with large vessel occlusion-AIS in our area the opportunity to receive the guideline-indicated treatment rapidly, with a chance for favorable functional outcomes much better than those after CSC transfer delays. The feedback and support we keep receiving from the local community is amazing and motivates us greatly in our continued availability to cover the primary PCI and MT (now combined) service. Similar solutions are adopted elsewhere in the country. We cannot reverse the severe disability of our stroke-affected catheterization laboratory nurse that made us act, but we are now able to effectively prevent many other human tragedies.

## ARTICLE INFORMATION

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## Poland—time to move on!

**Authors' reply** We appreciate the interest generated by our recent stroke thrombectomy clinical vignette.<sup>1</sup> A clinical vignette, opposite to an isolated case report, illustrates the fate of not one but hundreds of acute ischemic stroke (AIS) patients who continue to join (with all consequences) the severe disability lists because of a failed delivery of mechanical thrombectomy (MT), which is today not an "additional" treatment but the guideline-mandated, class of recommendation 1A, level of evidence 1 management.<sup>2</sup>

Messages highlighted by international key opinion leaders from 5 countries / 3 continents (including neuroradiology and neurosurgery) and by everyday MT operators (including cardiology) are consistent and unsurprising: 1) time is the fundamental principle in AIS—patients revascularized in 2 hours or less from stroke onset achieve approximately 90% good recovery whose likelihood, however, declines very significantly with time; thus, any avoidable transportation for MT harms severely; 2) with sparsely located comprehensive stroke centers (CSCs) and far too few operators, no neuroradiology-based system can effectively address the magnitude of the needs; 3) Poland's MT deliverability is amongst the world's lowest; 4) stroke international guidelines are clear on what and how should be done, and this is paralleled by working examples from different healthcare systems.

In Poland, a country of approximately 38 million residents, only 1111 MTs occurred between January and November 2019 (National Health Fund data; Stroke MT Program),<sup>1</sup> reaching a delivery level of less than 20% to 25%. With 60 000 strokes, Polish AIS patients require a minimum of 6000 to 8000 (and up to some 20 000) MTs per year. Thus, today, for every 5 patients with large-vessel occlusion AIS, less than 1 receives MT. For those supposedly fortunate to receive MT, many receive it too late for a full clinical recovery or a meaningful reduction of disability. Poland, once an international model of the heart attack care, is now amongst the 3 European leaders in the systemic *failure* of MT delivery for level of evidence 1A stroke clinical scenarios.<sup>3</sup> According to a large international survey, today it is better to be an average AIS patient in India (where the majority is not insured) than an average stroke patient in Poland.<sup>3</sup> If there "are" any true yet "different" data, those must be openly provided.

Reasons for failed MT deliveries are more than one,<sup>1</sup> but Poland's far-too-small number of MT centers and poor access to MT on a real (rather than theoretical) 24/7/365 basis is the number 1 reason communicated to the world by Poland's neurology and CSC MT leaders.<sup>4</sup>

Local multispecialty teams work well, joint in their common service to their community, unless<sup>5</sup> and until<sup>1</sup> disrupted by external politics focused on falsely perceived territorial protection rather than serving the needs of the patients. In AIS, territorial "protection"<sup>5</sup> might be regarded excusable *only* if the ones considering themselves the "owners" of the territory were able to deliver what in the contemporary world is a must-do.<sup>2</sup> "Protection" of a territory ("domain") at the cost of increased numbers of invalids (number needed to treat [NNT], 2.6) and dead bodies (NNT, 31) is not acceptable.<sup>5</sup> Contrary to the Ministry of Health regulations<sup>1</sup> endorsed by the Polish neurology leaders, subsequent stroke management

guidelines from the Polish Neurological Society state that “MT should be the domain of specialists in radiology, neurology or neurosurgery” (whose shortage translates into a greatly unmet need)<sup>4</sup> and step back (contrary to the Polish regulations,<sup>1</sup> international guidelines,<sup>2</sup> and stroke thrombectomy trials’ common practice) to the “on-site neurosurgery requirement” as a practical means to block creation of thrombectomy-capable centers. It is regrettable that our local neurology colleagues<sup>1</sup> were pressed by the manuscript reviewer to remove their names from the publication.<sup>1</sup> The problem of the patients, similarly untreated before and after the one described in the vignette<sup>1</sup> or systematically treated too late to achieve optimal outcomes because of insisting on avoidable transportation, remains. Local stroke neurologists will hopefully continue their work in the multispecialty Task Force<sup>1</sup> established to make MT available routinely to *their* patients, in *their* high-volume hospital.

Stroke is not a primary disease of the neuron but a *vascular* problem of the arteries that supply the brain. We call upon the stroke management stakeholders in Poland to come to one table (as we did when defining, under the auspices of the Ministry of Health, common requirements for MT operators),<sup>1</sup> and set up—with the map of Poland on the wall—an improvement process to provide a real rather than theoretical access to MT. With the magnitude of the misery, time is high today to replace those seemingly clever “yes-(but of course no)s” and glimpses in the eyes—with a sparkle for action. It is 100% clear that neither 17 nor 25 CSCs would ever be able to provide an operational (rather than theoretical) stroke MT service to a country of 38 million people. An occasional helicopter (rather than road) transport of a VIP solves neither the stroke problem of the VIP (considerable neuronal loss with avoidable transportation from a thrombectomy-capable center to a CSC and logistics, resulting in an increased stroke size) nor that of other patients who could (and should) be treated on-site rather than late or not at all.

Ill politics may slow down, but it shall not stop, the progress of medicine.<sup>5</sup> Cardiac catheterization laboratory-based thrombectomy-capable centers, as defined by stroke physicians<sup>2</sup> (termed “level 2” MT centers in neuroradiology guidelines), are a fact in the world. In many countries, including Poland’s neighbors, they deliver MT and the results not different from those in leading neuroradiology centers. Poland has presently ZERO of those.

How many more—avoidable—stroke victims and—avoidable—severe disabilities, including our work colleagues, public figures, or the decision-makers’ family members, are needed before the MT system in Poland gets fixed?

## ARTICLE INFORMATION

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