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# Time of the day and EVT\_Results from UNMASK EVT

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# Time of day and endovascular treatment decision in acute stroke with relative endovascular treatment indication: insights from UNMASK EVT international survey

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## ABSTRACT

**Background and purpose** The decision to proceed with endovascular thrombectomy should ideally be made independent of inconvenience factors, such as daytime. We assessed the influence of patient presentation time on endovascular therapy decision making under current local resources and assumed ideal conditions in acute ischemic stroke with level 2B evidence for endovascular treatment.

**Methods and materials** In an international cross sectional survey, 607 stroke physicians from 38 countries were asked to give their treatment decisions to 10 out of 22 randomly assigned case scenarios. Eleven scenarios had level 2B evidence for endovascular treatment: 7 daytime scenarios (7:00 am–5:00 pm) and four night time cases (5:01 pm–6:59 am). Participants provided their treatment approach assuming (A) there were no practice constraints and (B) under their current local resources. Endovascular treatment decisions in the 11 scenarios were analyzed according to presentation time with adjustment for patient and physician characteristics.

**Results** Participants selected endovascular therapy in 74.2% under assumed ideal conditions, and 70.7% under their current local resources of night time scenarios, and in 67.2% and 63.8% of daytime scenarios. Night time presentation did not increase the probability of a treatment decision against endovascular therapy under current local resources or assumed ideal conditions.

**Conclusion** Presentation time did not influence endovascular treatment decision making in stroke patients in this international survey.

## INTRODUCTION

Endovascular thrombectomy (EVT) is a highly effective proven treatment in acute ischemic stroke and now considered the standard of care in strokes due to emergent large vessel occlusion.<sup>1–6</sup> Acute stroke care requires a high level of commitment from healthcare professionals as stroke patients are often admitted outside regular working hours, including at night and

at weekends. As a consequence, practitioners' schedules are disrupted and physicians have to travel emergently to the hospital from home.<sup>7</sup> Limited staffing and restricted access to endovascular treatment resources beyond regular working hours are major concerns with regard to stroke treatment quality and efficiency. Endovascular treatment during the night often requires nocturnal patient transfer to a tertiary care facility, which has been shown to be associated with increased time delays.<sup>8</sup> Furthermore, once they have been notified, the neurointerventionalist and other hospital staff on-call still have to commute to the hospital. Not surprisingly, recent data show that presentation beyond work hours is associated with a significant delay of approximately 50min from onset to groin puncture and hence substantially affects patient care.<sup>9</sup>

However, despite prolonged door to reperfusion times, the recanalization and favorable outcome rates of stroke patients admitted at night or at weekends are comparable with those presenting during regular working hours.<sup>10</sup> Hence the decision to proceed with endovascular treatment should ideally be made independent of 'inconvenience factors', such as daytime. Treatment decisions in patients with acute ischemic stroke for which level 1A evidence exists are unambiguous and unlikely to be influenced by the time of day. However, inconvenience factors may have a greater impact on the decision making in cases for which level 2B evidence exists.

Using data from UNMASK EVT,<sup>11</sup> an international survey using prespecified case scenarios, we explored the influence of the time of day on endovascular treatment decision under the participants' current local resources and assumed ideal conditions in acute stroke with level 2B evidence for endovascular treatment.

## METHODS

### Survey design

We conducted an international cross sectional web based study (UNMASK-EVT) among stroke physicians and endovascular specialists to

understand their current treatment practice and endovascular decision making in acute stroke.<sup>11</sup> Participants were assigned to 10 case scenarios out of a pool of 22, and were asked how they would treat the patient in two distinct scenarios: (A) assuming there were no external (monetary or infrastructural) constraints and then (B) given their current local available resources. In this context, current local resources reflect financial restraints, infrastructural limitations (e.g. lack of access to endovascular treatment facilities during the night), personnel resources (e.g. a limited number of neurointerventionalists taking calls) as well as local practice patterns (i.e. institution specific policies regarding distal vessel occlusions, very old patients, etc). Response data were obtained from November 26, 2017 to March 27, 2018.

### Survey participants

A total of 1330 physicians who are routinely involved in acute stroke treatment (interventional neuroradiologists, endovascular neurosurgeons, stroke neurologists and general neurologists, internists, geriatricians, and other physicians who are routinely treating acute stroke patients) from 38 countries were invited to participate in this web based survey. No restrictions with regard to case volume or experience levels were applied, and participants had both academic and non-academic backgrounds.

### Clinical case scenarios

Twenty-two case scenarios were designed to assess participants' treatment practices, with emphasis on endovascular decision making in acute stroke. For detailed descriptions of the case scenarios with corresponding presentation times, see online supplementary material 1. Eight scenarios discussed cases with level 1A evidence, 11 with level 2B evidence, and 3 scenarios were not covered by the current American Heart Association/American Stroke Association guidelines (pediatric stroke, EVT in a patient with metastatic cancer, and a patient with a recent stroke).<sup>4</sup> Among the level 2B scenarios, seven occurred during the daytime, that is, between 7:00 am and 5:00 pm (presentation times: 8:00 am, 9:00 am, 10:00 am, 1:00 pm, 2:00 pm, 3:00 pm, and 4:00 pm), and four night time scenarios occurred off hours, between 5:01 pm and 6:59 am (presentation times: 11:00 pm, 2:00 am, 3:00 am, and 5:00 am).

### Statistical analysis

Multivariable stepwise logistic regression was used to determine the influence of presentation time (daytime vs night time) on EVT decision rates under current resources and under ideal conditions, with adjustment for important predictors (baseline Alberta Stroke Program Early CT score (ASPECTS), time from onset to presentation, patient age, occlusion site (proximal (i.e. internal carotid artery or M1) vs distal (i.e. M2)), baseline functional status (dependent vs independent), physician experience in terms of years in practice, and physician age). Countries with <10 responses for daytime and night time level 2B evidence scenarios have been excluded in country specific analyses. P values <0.05 were considered significant. Data analysis was performed in Stata 15.1. Graphs were created with Microsoft Excel and maps with Microsoft Power BI desktop 2016 using the Mapbox Visual Plugin.

## RESULTS

### Survey completion rate and overall treatment decision

A total number of 607 physicians (97 women (16.0%), 508 (83.7%) men, and 2 (0.3%) who did not disclose their gender) of different subspecialties (326 neurologists (53.7%), 173

**Table 1** Baseline characteristics of the daytime and night time case scenarios

Characteristic	Daytime scenarios	Night time scenarios
Level 1A scenarios (n (%))	8 (47.1)	0 (0)
Level 2B scenarios (n (%))	7 (41.2)	4 (80.0)
Scenarios without guideline coverage (n (%))	2 (11.8)	1 (20.0)
Baseline ASPECTS score (median (IQR))	7 (7–9)	7 (6–7)
Time from onset to presentation (hours) (median (IQR))	2.5 (2–3)	3 (3–3)
Patient age (years) (median (IQR))	69 (56–72)	85 (80–85)
History of previous strokes (n (%))	1 (5.9)	0 (0)
Site of occlusion (n (%))	ICA: 2 (11.8) M1: 12 (70.6) M2: 3 (17.6)	ICA: 1 (20.0) M1: 2 (40.0) M2: 2 (40.0)
No independent baseline functional status (n (%))	0 (0)	1 (20.0)

ASPECTS, Alberta Stroke Program Early CT score; ICA, internal carotid artery.

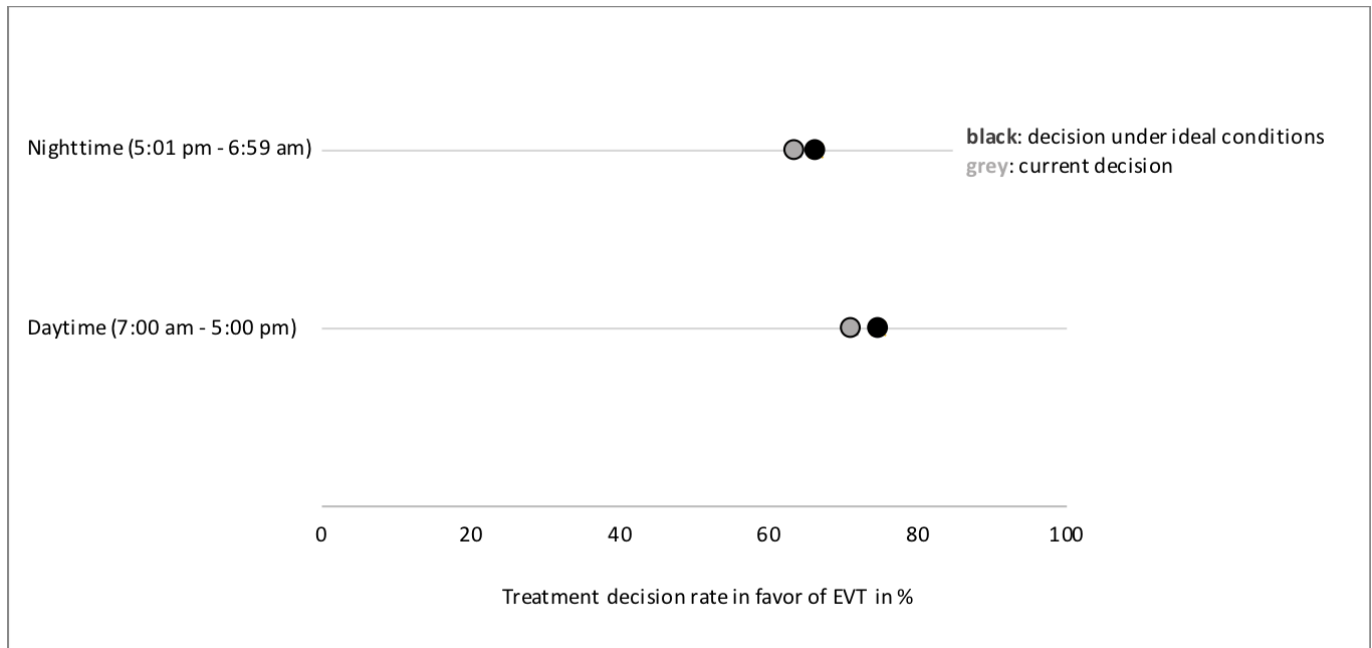
interventional neuroradiologists (28.5%), 81 endovascular neurosurgeons (13.3%), 5 internists (0.8%), 2 geriatricians (0.3%), and 20 (3.3%) physicians of other specialties) from 38 countries completed the survey, and there were 6070 responses (3034 for 11 level 2B scenarios overall; daytime scenarios, 1930 responses; night time scenarios, 1104 responses). Overall treatment decision rates were in favor of EVT: overall sample 75.6% (n=4586/6070) under current resources and 79.0% (n=4793/6070) under assumed ideal conditions. In level 1A scenarios, 86.8% (n=1917/2208) favored EVT under current resources and 90.6% (n=2001/2208) under ideal conditions, while in level 2B scenarios, the values were 66.3% (n=2011/3034) under current resources and 69.7% (n=2115/3034) under ideal conditions. Table 1 shows the characteristics of the daytime and night time case scenarios.

### Overall treatment decision in level 2B scenarios

Under their current local resources, participants opted in favor of EVT in 63.8% in the daytime scenarios and in 70.7% in the night time scenarios (figure 1). Multivariable analysis adjusted for important predictors revealed that night time presentation did not lead to an increased treatment decision rate against EVT (P=0.373), while baseline ASPECTS (OR=0.92, P<0.001), time since symptom onset (OR=0.97, P=0.041), proximal occlusion site (OR=1.23, P<0.001), and independent baseline functional status (OR=4.21, P<0.001) were significant predictors for the treatment decision.

The treatment decision in favor of EVT assuming ideal conditions was 67.2% in the daytime and 74.2% in the night time scenarios (figure 1). Multivariable analysis showed that night time presentation did not significantly increase the treatment decision against EVT (P=0.349). In contrast, baseline ASPECTS (OR=0.90, P<0.001), time since symptom onset (OR 0.94, P<0.001), site of occlusion (OR 1.32, P<0.001), baseline functional status (OR 7.3, P<0.001), and physician experience (OR 1.0, P=0.003) were significant predictors.

The overall decision rate in favor of EVT under current local resources was significantly lower than under assumed ideal conditions (difference for daytime scenarios: 5.4%, P<0.001; difference for night time scenarios: 3.4%, P<0.001).



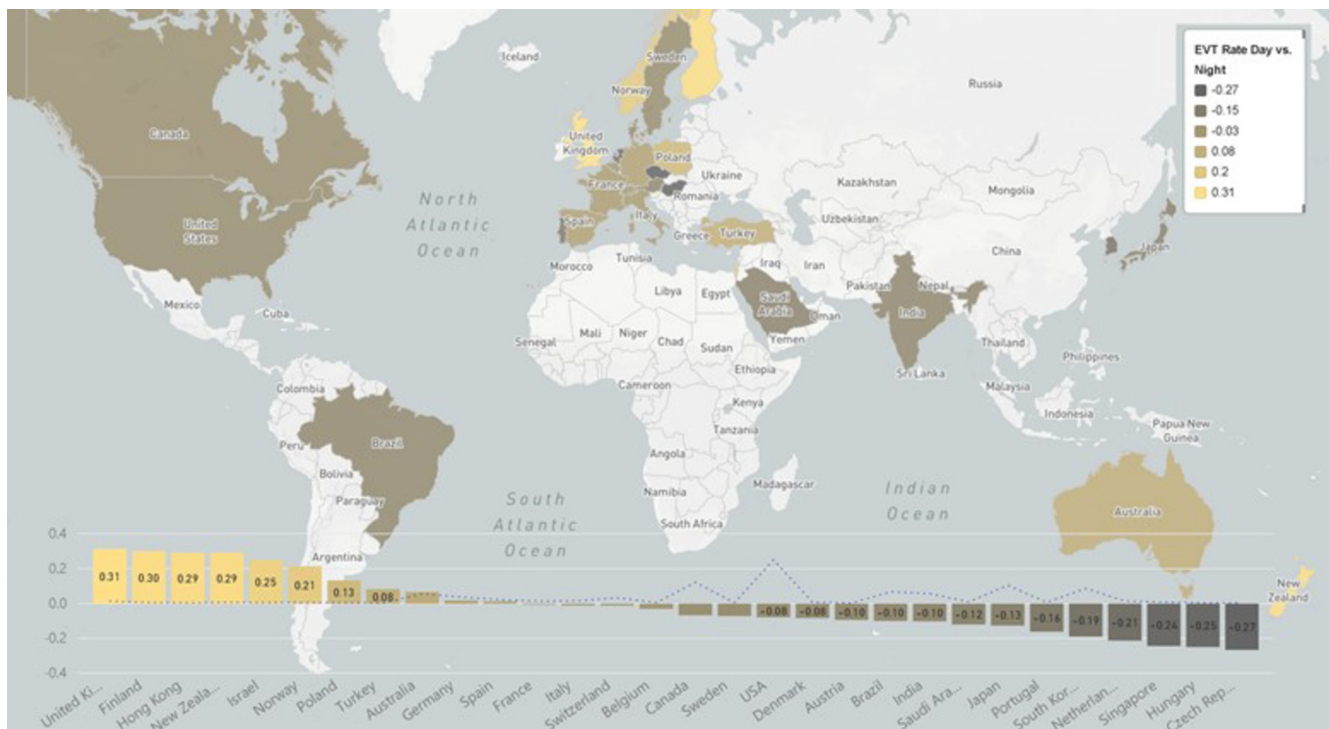
**Figure 1** Overall treatment decision rates in level 2B scenarios in favor of endovascular thrombectomy (EVT) were higher for night time case scenarios compared with daytime scenarios, both under assumed ideal conditions (black) and under current resources (gray).

**Geographic variations in daytime and night time treatment decisions**

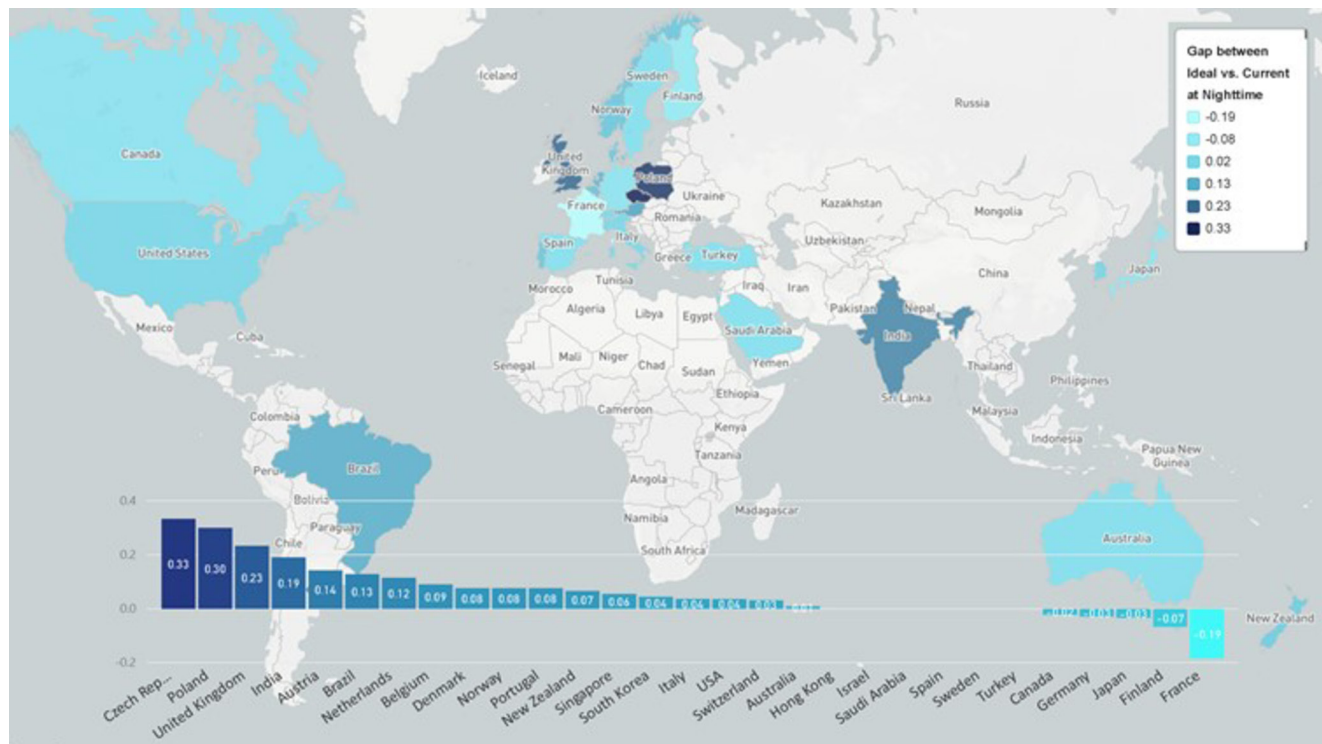
Given the available current local resources, the discrepancy in EVT decision between daytime and night time scenarios differed substantially between countries (figure 2). While physicians in the UK and Finland opted approximately 30% more often for

EVT during the day, those in Hungary and the Czech Republic decided around 25% more often in favor of EVT during the night.

When comparing the discrepancies between treatment decisions under assumed ideal conditions versus current local resources, large differences were observed across countries



**Figure 2** Difference between current daytime and night time endovascular treatment decision rates in level 2B scenarios. Yellow colors and upward facing bars represent higher endovascular thrombectomy (EVT) decision rates in daytime scenarios, dark colors and downward facing bars show higher treatment decision rates in favor of EVT in night time scenarios. The broken blue line indicates the number of responses per country. Countries with <10 responses for daytime and night time level 2B evidence scenarios have been excluded in this illustration.



**Figure 3** Difference between current and ideal endovascular treatment decision in level 2B night time scenarios. Large bars represent large discrepancies between the current and ideal treatment decision, small bars show small discrepancies. Dark color and upward facing bars indicate that physicians would offer endovascular thrombectomy (EVT) under ideal conditions but they cannot because of local restraints. Light color and downward facing bars indicate that EVT was chosen under current local resources, but physicians would not offer EVT under assumed ideal conditions. Countries with <10 responses for daytime and night time level 2B evidence scenarios have been excluded in this illustration.

(figure 3). While physicians in the Czech Republic, Poland, and the UK would want to offer EVT in 23–33% but could not in their current local working environment, physicians in Finland and France stated that they would perform EVT in 7% and 19% of cases under local resources, but not in an ideal environment.

## DISCUSSION

In the present study, we evaluated night time and daytime EVT treatment decisions in level 2B evidence case scenarios and overall decision rates for level 1A scenarios. Despite level 2B evidence for endovascular treatment, physicians' overall decision in favor of EVT was high, under both ideal conditions and current resources (69.7% and 66.3%, respectively).

Offering EVT in cases with level 2B evidence will increase endovascular treatment cases beyond the current numbers. In order to do this, sufficient endovascular treatment access and supportive local treatment policies are required, as well as physicians who are willing to perform additional EVT procedures in the absence of strong guideline recommendations. The physicians' support for EVT in these scenarios is a testament to their regard for EVT as a highly effective treatment in such cases and may also point towards an aggressive treatment approach. On the other hand, we observed substantial treatment variability in level 1A scenarios as participants decided not to treat approximately 1 of 10 EVT eligible patients, even when assuming ideal conditions. The individual reasons that caused physicians to refrain from EVT in level 1A evidence cases were not captured in this study and should be explored in future research.

Our study showed a substantial 'resources gap' between the EVT decision rates under current local resources and ideal conditions, confirming findings of previous population based studies.<sup>12</sup>

Several external factors prevent physicians from delivering the best possible stroke treatment. In most developing countries, the lack of equipped medical facilities is a major limitation for effective stroke treatment.<sup>13</sup> Given the increasing demand for EVT, even nations with established systems of care are facing serious challenges. Prolonged patient transfer times have been shown to be associated with worse patient outcome<sup>14 15</sup> and new organizational concepts are required in order to minimize transfer times.

Multivariable analysis showed that the odds for a treatment decision in favor of EVT when facing level 2B evidence did not differ between night time and daytime cases in this survey. This suggests that night time presentation as an inconvenience factor generally does not bias physicians towards refraining from EVT, and stroke patients presenting at night are not at a disadvantage. However, our survey revealed vast differences between the daytime and night time decision patterns in different countries. Physicians in Finland and France, for example, stated that they would offer endovascular treatment in the level 2B night time scenarios less frequently under assumed ideal conditions than under current local resources (figure 3). This is probably a result of local endovascular treatment policies and should be further investigated. However, in the vast majority of countries, physicians would want to offer EVT in level 2B night time scenarios under ideal conditions, but cannot under their current local working resources. Those countries in which physicians' current night time decision rates were substantially lower (>10%) than the daytime decision rates—namely, the Czech Republic, Poland, UK, India, Austria, Brazil, and The Netherlands (figure 3)—deserve closer attention as such a constellation is suggestive of insufficient access to endovascular treatment facilities during the night.

Our study is subject to the limitations typical of any survey based findings. Although the case scenarios used in this survey were designed by experienced stroke physicians, a survey cannot accurately depict real life endovascular decisions and there is the possibility that physicians' real life decisions differ from the hypothetical case scenarios. This is more likely in situations in which interventionalists face an exceptionally high work burden or are on-call during over consecutive busy nights. There is a chance that they might refrain from endovascular treatment of borderline cases because of overwork and exhaustion, although they would proceed with EVT under 'normal' circumstances. Another limitation of our survey is the potential selection bias. Those physicians who participated might be a more aggressive cohort selected by their willingness to respond. Furthermore, participants' enrollment was based on the authors' personal networks and cooperations. While the overall completion rate of 45.6% was high compared with other surveys, the number of participating physicians from some countries was low.

Despite these limitations, this study is a first step towards exploring the influence of presentation time on treatment attitudes of stroke physicians from different nations and specialties, and could potentially help to identify areas with limited access to treatment facilities beyond working hours.

## CONCLUSION

In this study, endovascular treatment decision making was not influenced by presentation time. The majority of participating physicians decided in favor of EVT despite facing only level 2B evidence. Overall treatment rates for level 1A scenarios were even higher, with potential room for improvement. Night time EVT decision rates under current resources in seven countries were substantially lower than decision rates under ideal conditions, implying a regional lack of endovascular treatment resources at night.

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**Correction notice** Since this article was first published online, the author Pillai Sylaja has had their middle initial N added to their name.

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**Competing interests** MG is a consultant for Medtronic, Stryker, Microvention, GE Healthcare, and Mentice. UF is a consultant for Medtronic, Stryker, and CSL Behring, and co-PI of the SWIFT DIRECT trial (Medtronic). FT works as a consultant for Balt and Stryker. BWB works as a consultant for Penumbra, Medtronic, Stryker, 880 Medical and Metactive, owns stock options (Penumbra, Viz.ai), and has ownership interests on Route 92 and Marblehead. GS is supported by the Heart and Stroke Foundation of Canada Career Award.

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