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# Effectiveness of the AVANT neurorehabilitation training program on stroke rehabilitation awareness and practice in Vietnam

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**ABSTRACT**
Stroke remains the leading cause of disability in Vietnam, yet awareness of stroke rehabilitation remains limited. The AVANT (Austrian Vietnamese Advancement Neurorehabilitation Treatment) Program, launched in 2017, aims to address this gap by training healthcare professionals and caregivers in motor recovery practices. This study evaluated the AVANT program's structure, content, and impact on stroke rehabilitation awareness, using a single-arm pre-post design without a control group for caregivers and a cross-sectional survey for healthcare professionals. Data were collected from 96 stroke units, each represented by one healthcare professional (Class A) and 3,352 caregivers (Class B). Post-training results showed significant improvements in knowledge and practices, with 90% of caregivers understanding the timing of rehabilitation initiation compared with 13.9% previously. The proportion of departments with no specific rehabilitation method fell from 58% to 0%, while the proportion following AVANT-specified exercises rose to 95% after training. These findings suggest that AVANT is associated with improved stroke rehabilitation knowledge and practices in Vietnam. As this was an observational study without a control group or direct patient outcome measures, further controlled studies are needed to confirm its impact on patient recovery.

**KEYWORDS:** AVANT; post-stroke rehabilitation; stroke; neurorehabilitation; health education; caregivers; Vietnam; program evaluation

**ABBREVIATIONS:** AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment; BP, blood pressure; CI, confidence interval; CV, cardiovascular; EAN, European Academy of Neurology; EFNR, European Federation of NeuroRehabilitation Societies; MD, medical doctor; OT, occupational therapy; PT, physical therapy; Rx, prescription; WSO, World Stroke Organization.

## INTRODUCTION

Stroke is a leading cause of death and disability worldwide, with over 12.2 million new cases and more than 6.5 million deaths annually, imposing substantial economic and social burdens on patients, families, and health systems [1-4]. Vietnam, a developing country in Southeast Asia, has struggled to achieve expected healthcare system advancements. Over the past two decades, the incidence and mortality rates of stroke in Vietnam have risen steadily, disproportionately affecting younger populations and positioning stroke as the leading cause of death [5]. One key factor contributing to this alarming trend is the lack of public awareness and knowledge about stroke and post-stroke rehabilitation [6,7]. Awareness gaps delay diagnosis, emergency response, and treatment, significantly reducing patients' chances of recovery. Furthermore, inadequate understanding of post-stroke rehabilitation exacerbates neural damage, prolongs recovery timelines, and increases treatment costs. Addressing these issues requires a strategic approach that emphasizes education on stroke prevention, management, and rehabilitation [8,9].

The establishment of the first stroke unit in Vietnam at the 108 Military Central Hospital in 2002 marked a critical milestone in stroke care. Over the subsequent 20 years, the country has expanded to more than 100 stroke units [5]. However, small-scale surveys indicate that public awareness of stroke remains limited [10]. Recognizing this gap, the AVANT Program was launched in 2017 as an international collaboration involving the World Stroke Organization, the Vietnam General Medical Association, the Vietnam Stroke Association, and the Vietnam



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Rehabilitation Association. The program aims to improve stroke patients' reintegration into the community by enhancing the knowledge and understanding of healthcare professionals (Class A) and caregivers (Class B). AVANT provides comprehensive training in general stroke knowledge, prevention strategies, and basic rehabilitation techniques [11,12].

This study aimed to evaluate the current state of stroke treatment facilities in Vietnam, assess community awareness of stroke and rehabilitation, and provide a preliminary analysis of the AVANT program's impact since its implementation. By identifying critical gaps, the AVANT program aims to lay the foundation for further advances in stroke care and rehabilitation.

## MATERIAL AND METHODS

### Study design and participants

This study combined a prospective, single-arm pre-post educational intervention design among caregivers with a cross-sectional survey of healthcare professionals, conducted between May 2020 and March 2023, to evaluate the impact of the AVANT program on stroke awareness and rehabilitation practices in Vietnam. The study involved two distinct participant groups: 96 stroke units across Vietnam, each represented by one healthcare professional respondent (AVANT-A class), and 3,352 caregivers of stroke patients (AVANT-B class). Healthcare professionals were selected from certified stroke units across Vietnam and had completed the AVANT program training between May 2020 and May 2022. Caregivers, aged 18 to 70 years, were recruited from five major stroke centers in Northern Vietnam, namely the 108 Military Central Hospital, Bach Mai Hospital, 103 Military Hospital, Phu Tho Provincial General Hospital, and Thanh Hoa Provincial General Hospital. Data collection for caregivers took place between May 2022 and March 2023 (Figure 1).

### Eligibility

The inclusion criteria required caregivers to be actively involved in emergency care, inpatient care, or post-discharge rehabilitation for stroke patients. Healthcare professionals were required to work in certified stroke units and to voluntarily consent to participate. Exclusion criteria included caregivers unable to read or understand the questionnaire and those who declined to participate in the study. Caregivers were primarily recruited through referrals from treating physicians at the participating hospitals as part of routine efforts to improve patient care; a smaller number learned about the AVANT program through educational videos or the program website and self-enrolled in the nearest available class. Systematic records of participation or refusal rates were not maintained and are therefore not reported; this is noted as a limitation below.

### The AVANT training program

The AVANT training program consisted of a 5-day course (8 hours per day, approximately 40 hours) that combined theoretical instruction, hands-on practical sessions led by rehabilitation technicians, and simulation-based practice with patients from the host hospital. All classes and locations used a standardized curriculum, including a textbook, lecture slides, handouts, and a practical training manual, appraised by the Vietnam Ministry of Health and published by the Medical Publishing House.

### Ethical considerations

This study was conducted as part of the routine evaluation of the AVANT training program, an ongoing educational and quality improvement initiative delivered within existing training activities. As the study involved a fully anonymized, voluntary knowledge and practice questionnaire, with no clinical intervention, no

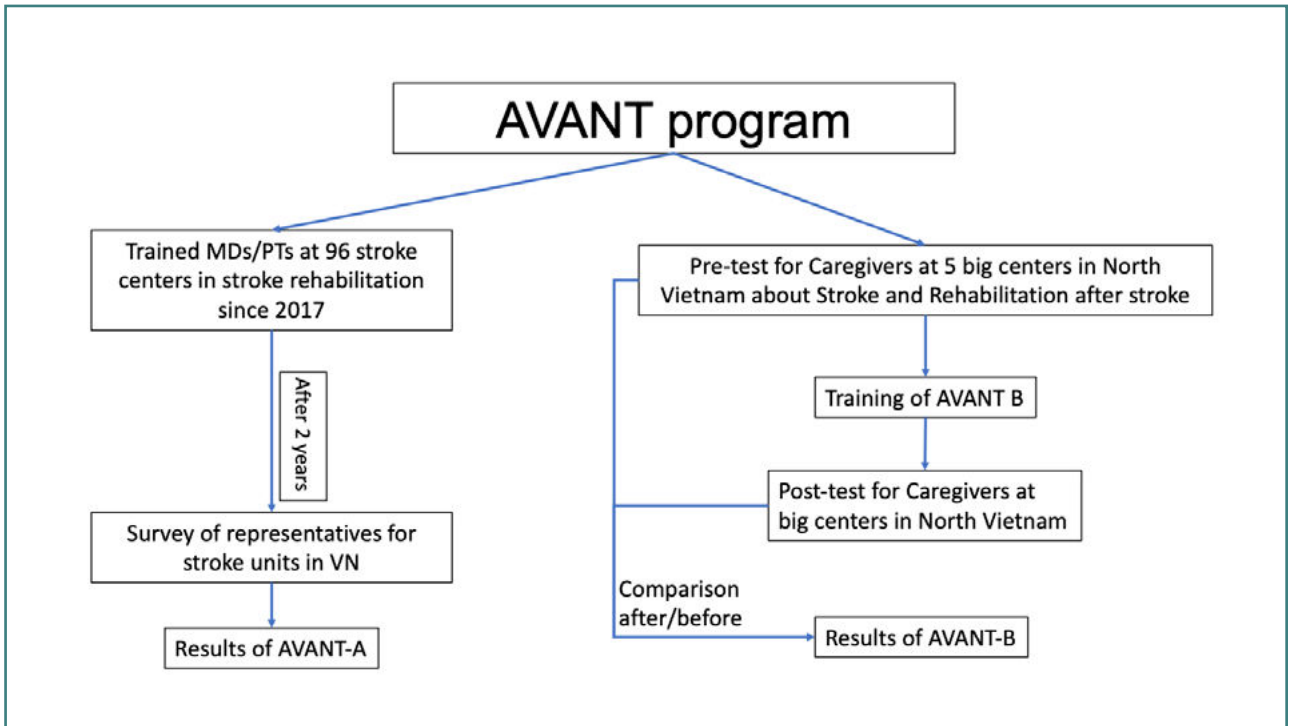



**Figure 1. Diagram of the AVANT study**



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alteration of patient care, and no collection of identifiable patient information, formal review by an institutional ethics committee was not required, consistent with the exemption commonly applied to program evaluation and quality improvement activities in this setting. This determination was made by the study investigators; no institutional ethics committee or other regulatory body was formally consulted for a waiver or exemption. All participants, healthcare professionals and caregivers, were informed of the purpose of the survey and its voluntary, anonymous nature before completing the questionnaire, and participation was considered to imply consent. The study was conducted in accordance with the Declaration of Helsinki.

### Questionnaires

The Class A (healthcare professional) and Class B (caregiver) questionnaires were newly developed by the study team for the AVANT program, as no previously validated instrument covering this specific content was identified. Content was informed by consultation with senior rehabilitation and neurology specialists during development, and the questionnaires were pilot-tested at a stroke unit within the 108 Military Central Hospital prior to full-scale administration. One representative doctor from each participating department completed the Class A questionnaire, which combined individual clinical knowledge items with department-level practice indicators; caregivers completed the Class B questionnaire, a self-administered true/false and multiple-choice instrument, anonymously immediately before and after each training session. Formal reliability (e.g., Cronbach's alpha) and validity testing were not conducted; this is acknowledged as a limitation below.

### Data collection and statistical analysis

Surveys were conducted before and after the AVANT training to assess participants' knowledge and practices. Healthcare professionals completed surveys to evaluate their awareness of rehabilitation knowledge and its application within their facilities post-training. Caregivers answered true/false questions designed to assess their understanding of stroke risk factors, symptoms, timing of rehabilitation, and key practices such as patient positioning and aspiration prevention. We used a consecutive sampling technique for data collection. The collected data were processed using GraphPad Prism v10.0 (GraphPad Software, San Diego, CA, USA). We used descriptive statistics to present frequencies and percentages for qualitative variables and means for continuous variables. Inferential statistics, specifically chi-square tests, were used to compare pre- and post-training results, with statistical significance set at $P < 0.05$.

## RESULTS

### Current understanding of stroke in the community

Risk factors for stroke were correctly identified with frequencies ranging from 30.22% to 57.76%, with hypertension and cardiovascular disease being the most recognized (Figure 2A, Table 1). However, many risk factors were not considered, as indicated by a high rate of non-selections (Table 2).

For stroke onset symptoms, correct identification ranged from 33.35% to 50.36%. Misidentifications were common, with symptoms such as shortness of breath, chest pain, and

**Table 1. Caregiver recognition of stroke risk factors before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| **Risk factor recognized** | | | | | |
| Hypertension | 1936 | 57.76% | 3300 | 98.45% | *P* < 0.001 |
| Diabetes | 1260 | 37.59% | 3174 | 94.69% | *P* < 0.001 |
| Dyslipidemia | 1190 | 35.50% | 3212 | 95.82% | *P* < 0.001 |
| Cardiovascular diseases | 1417 | 42.27% | 3245 | 96.81% | *P* < 0.001 |
| Smoking | 1064 | 31.74% | 2993 | 89.29% | *P* < 0.001 |
| Drinking (alcohol) | 1183 | 35.29% | 3108 | 92.72% | *P* < 0.001 |
| Old age | 1191 | 35.53% | 3056 | 91.17% | *P* < 0.001 |
| Physical inactivity | 1062 | 31.68% | 3006 | 89.68% | *P* < 0.001 |
| Recurrent stroke | 1264 | 37.71% | 3203 | 95.55% | *P* P < 0.001 |
| Obesity | 1013 | 30.22% | 2988 | 89.14% | *P* < 0.001 |
| **Level of correct selection** | | | | | |
| Bad (≤3 correct) | 1799 | 53.67% | 71 | 2.12% | *P* < 0.001 |
| Medium (4–6 correct) | 619 | 18.47% | 126 | 3.76% | *P* < 0.001 |
| Good (≥7 correct) | 934 | 27.86% | 3155 | 94.12% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment. Caregivers, *n* = 3,352. Comparison of the proportion answering correctly before and after training using the chi-square test.



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**Figure 2. Changing perceptions of stroke risk factors, onset symptoms and signs, and prevention. Radar charts show the correct-answer rate for each individual item before and after the AVANT program; bar charts show the overall level of correct selections (bad, ≤ 3; medium, 4–6; good, ≥ 7). (A) Risk factors; (B) onset symptoms and signs; (C) prevention. Caregivers and healthcare professionals, *n* = 3352. Comparisons were made using the chi-square test; all *P* < 0.001.**



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**Table 2. Caregiver non-responses on stroke risk factors before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| Hypertension | 1280 | 38.19% | 47 | 1.40% | *P* < 0.001 |
| Diabetes | 1729 | 51.58% | 109 | 3.25% | *P* < 0.001 |
| Dyslipidemia | 1332 | 39.75% | 92 | 2.74% | *P* < 0.001 |
| Cardiovascular diseases | 1202 | 35.86% | 81 | 2.42% | *P* < 0.001 |
| Smoking | 1895 | 56.53% | 178 | 5.31% | *P* < 0.001 |
| Drinking (alcohol) | 1785 | 53.27% | 116 | 3.46% | *P* < 0.001 |
| Old age | 1817 | 54.21% | 190 | 5.67% | *P* < 0.001 |
| Physical inactivity | 1909 | 56.95% | 185 | 5.52% | *P* < 0.001 |
| Recurrent stroke | 1805 | 53.85% | 113 | 3.37% | *P* < 0.001 |
| Obesity | 1943 | 57.97% | 200 | 5.97% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment. Caregivers, *n* = 3,352. Comparisons were made using the chi-square test.

**Table 3. Caregiver recognition of stroke onset signs before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| **Onset sign recognized** | | | | | |
| Facial paralysis | 1688 | 50.36% | 3282 | 97.91% | *P* < 0.001 |
| Hemiparesis | 1540 | 45.94% | 3283 | 97.94% | *P* < 0.001 |
| Aphasia | 1393 | 41.56% | 3262 | 97.32% | *P* < 0.001 |
| Dizziness | 1269 | 37.86% | 2945 | 87.86% | *P* < 0.001 |
| Loss of balance | 1271 | 37.92% | 3090 | 92.18% | *P* < 0.001 |
| Chest pain† | 442 | 13.19% | 1171 | 34.93% | *P* < 0.001 |
| Difficulty breathing† | 400 | 11.93% | 1210 | 36.10% | *P* < 0.001 |
| Nausea/vomiting† | 395 | 11.78% | 2500 | 74.58% | *P* < 0.001 |
| Heart palpitations† | 347 | 10.35% | 1005 | 29.99% | *P* < 0.001 |
| Severe headache | 1118 | 33.35% | 3097 | 92.39% | *P* < 0.001 |
| **Level of correct selection** | | | | | |
| Bad (≤3 correct) | 1900 | 56.68% | 103 | 3.07% | *P* < 0.001 |
| Medium (4–6 correct) | 562 | 16.77% | 1930 | 57.58% | *P* < 0.001 |
| Good (≥7 correct) | 890 | 26.55% | 1319 | 39.35% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment. Caregivers, *n* = 3,352. Comparisons were made using the chi-square test.
† Non-stroke symptom, included to assess misidentification; a higher value therefore indicates poorer performance.

palpitations being mistaken for stroke symptoms, with error rates between 10.35% and 13.19% (Figure 2B, Table 3). Many respondents left even typical symptoms, such as facial drooping and hemiplegia, unselected (Tables 3 and 4).

When asked about first aid measures for suspected stroke cases, only 24.25% indicated they would call emergency services (115, the national emergency number in Vietnam). Notably, 3.96% opted for Gua Sha (skin scraping) and 19.12% chose fingertip bloodletting as initial responses. Over half of respondents (50.52%) did not select any first-aid measure (Figure 3, Table 5).

For stroke prevention, correct identification rates ranged from 24.22% (weight loss) to 47.02% (annual health check-ups). Misconceptions persisted, with 12.92% believing that taking a specific medication could prevent stroke (Figure 2C, Tables 6 and 7).



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**Table 4. Caregiver non-responses on stroke onset signs before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| Facial paralysis | 1500 | 44.75% | 54 | 1.61% | *P* < 0.001 |
| Hemiparesis | 1604 | 47.85% | 60 | 1.79% | *P* < 0.001 |
| Aphasia | 1717 | 51.22% | 71 | 2.12% | *P* < 0.001 |
| Dizziness | 1786 | 53.28% | 334 | 9.96% | *P* < 0.001 |
| Loss of balance | 1773 | 52.89% | 179 | 5.34% | *P* < 0.001 |
| Chest pain | 2045 | 61.01% | 581 | 17.33% | *P* < 0.001 |
| Difficulty breathing | 1995 | 59.52% | 587 | 17.51% | *P* < 0.001 |
| Nausea/vomiting | 1964 | 58.59% | 496 | 14.80% | *P* < 0.001 |
| Heart palpitations | 2048 | 61.10% | 553 | 16.50% | *P* < 0.001 |
| Severe headache | 1924 | 57.40% | 160 | 4.77% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment. Caregivers, *n* = 3,352. Comparisons were made using the chi-square test.

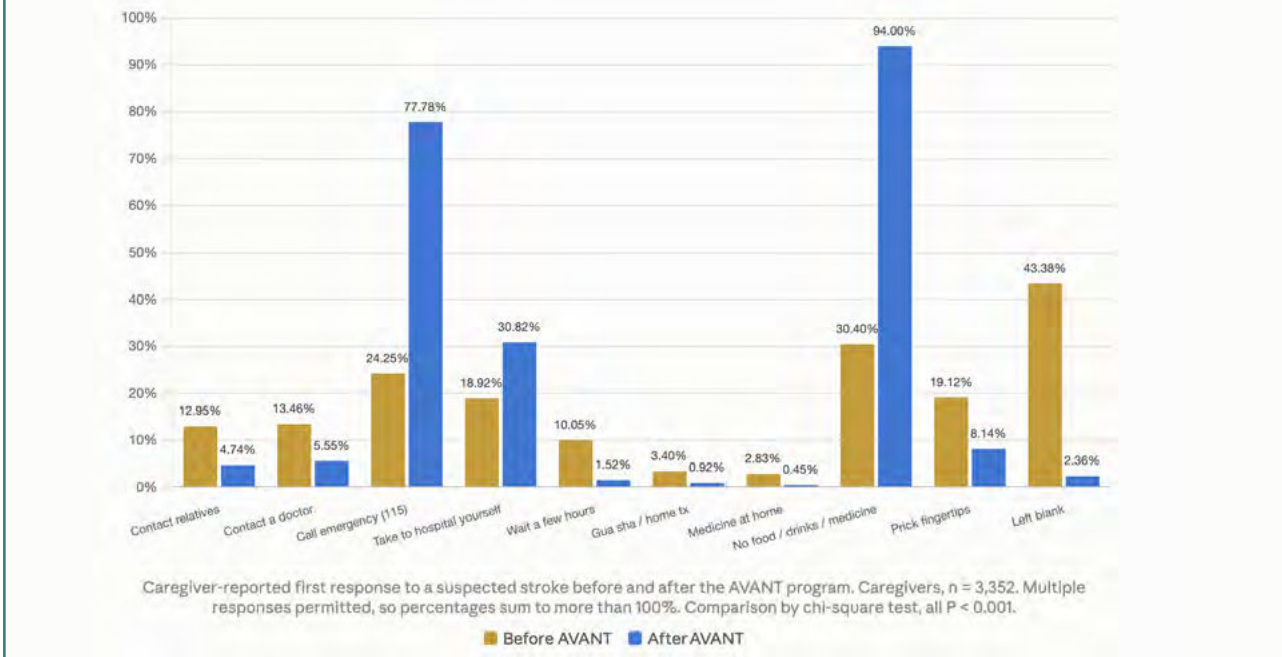



**Figure 3. Caregiver-reported first response to a suspected stroke before and after the AVANT program. Caregivers, *n* = 3352. Comparisons were made using the chi-square test; all *P* < 0.001.**

## Current state of Vietnamese post-stroke rehabilitation

Caregivers demonstrated limited understanding of rehabilitation before participating in the AVANT program. Only 37.08% believed rehabilitation was necessary post-stroke (Table 8), and 26.73% thought rehabilitation was the shared responsibility of medical staff and caregivers, while 14.41% believed it was solely the responsibility of medical staff (Figure 4A). Knowledge about the timing of rehabilitation and basic practices was also not well established: only 13.48% identified the correct time to start rehabilitation (24-48 hours post-onset, depending on the patient's stability post-stroke), and 27.27% knew that repositioning patients every 2 hours is essential (Figure 4B and 4C).

## Responsibility for patients' rehabilitation

Before AVANT, rehabilitation was not included in the stroke treatment protocol in 17% of stroke units. Early rehabilitation within 3 days of stroke onset occurred in just 30% of cases, while 24% started after one week and 29% initiated rehabilitation only after discharge (Figure 5AB). Rehabilitation was delivered in the stroke department in 39% of units and in a dedicated neurorehabilitation department in 48% (Figure 5C). Moreover, only 73% of medical staff recognized the benefit of combining neurotrophic agents, such as Cerebrolysin, with rehabilitation therapy [13], and just 35% reported combining Cerebrolysin specifically (Figure 5D).



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## Effectiveness of the AVANT program

The AVANT program significantly improved stroke caregivers' and medical professionals' knowledge. Correct identification of stroke risk factors increased from 30.22%–57.76% before training to 89.14%–98.45% after training, with poor knowledge rates dropping from 53.67% to 2.12%. Awareness of stroke symptoms and appropriate emergency responses, such as calling emergency services, rose from 24.25% to 77.78%, while unscientific practices such as Gua Sha decreased significantly (Figure 3, Table 5). Among medical staff, the proportion correctly identifying the timing to start rehabilitation increased from 30% to 86% (Figure 5A).

Knowledge of aspiration-prevention techniques improved

**Table 5. Caregiver-reported first response to a suspected stroke before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| **Response chosen** | | | | | |
| Contact patient's relatives | 434 | 12.95% | 159 | 4.74% | *P* < 0.001 |
| Contact a doctor you know | 451 | 13.46% | 186 | 5.55% | *P* < 0.001 |
| Call emergency services (115) | 813 | 24.25% | 2607 | 77.78% | *P* < 0.001 |
| Take patient to hospital yourself | 634 | 18.92% | 1033 | 30.82% | *P* < 0.001 |
| Wait a few hours then go | 337 | 10.05% | 51 | 1.52% | *P* < 0.001 |
| Gua sha / home treatment | 114 | 3.40% | 31 | 0.92% | *P* < 0.001 |
| Take medicine at home (no Rx) | 95 | 2.83% | 15 | 0.45% | *P* < 0.001 |
| No food/drinks/medicine | 1019 | 30.40% | 3151 | 94.00% | *P* < 0.001 |
| Prick fingertips to let blood | 641 | 19.12% | 273 | 8.14% | *P* < 0.001 |
| Left blank / no selection | 1454 | 43.38% | 79 | 2.36% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment. Caregivers, *n* = 3,352. Multiple responses permitted, so percentages sum to more than 100%. Comparisons were made using the chi-square test.

**Table 6. Caregiver knowledge of stroke prevention before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| **Prevention measure identified** | | | | | |
| Annual health check-ups | 1576 | 47.02% | 3255 | 97.11% | *P* < 0.001 |
| Blood pressure control | 1336 | 39.86% | 3242 | 96.72% | *P* < 0.001 |
| Blood sugar control | 1126 | 33.60% | 3213 | 95.85% | *P* < 0.001 |
| Cholesterol control | 1074 | 32.04% | 3202 | 95.53% | *P* < 0.001 |
| Treatment/prevention of CV | 1090 | 32.52% | 3179 | 94.84% | *P* < 0.001 |
| Weight loss | 812 | 24.22% | 2994 | 89.32% | *P* < 0.001 |
| Limit alcohol intake | 1053 | 31.41% | 3125 | 93.23% | *P* < 0.001 |
| Regular exercises | 1084 | 32.34% | 3143 | 93.79% | *P* < 0.001 |
| Avoid stress | 945 | 28.19% | 3037 | 90.60% | *P* < 0.001 |
| Take one special medicine only | 433 | 12.92% | 89 | 2.66% | *P* < 0.001 |
| **Level of correct selection** | | | | | |
| Bad (≤3 correct) | 2054 | 61.28% | 102 | 3.04% | *P* < 0.001 |
| Medium (4–6 correct) | 468 | 13.96% | 83 | 2.48% | *P* < 0.001 |
| Good (≥7 correct) | 830 | 24.76% | 3167 | 94.48% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment; CV, cardiovascular. Caregivers, *n* = 3,352. Comparison using chi-square test.



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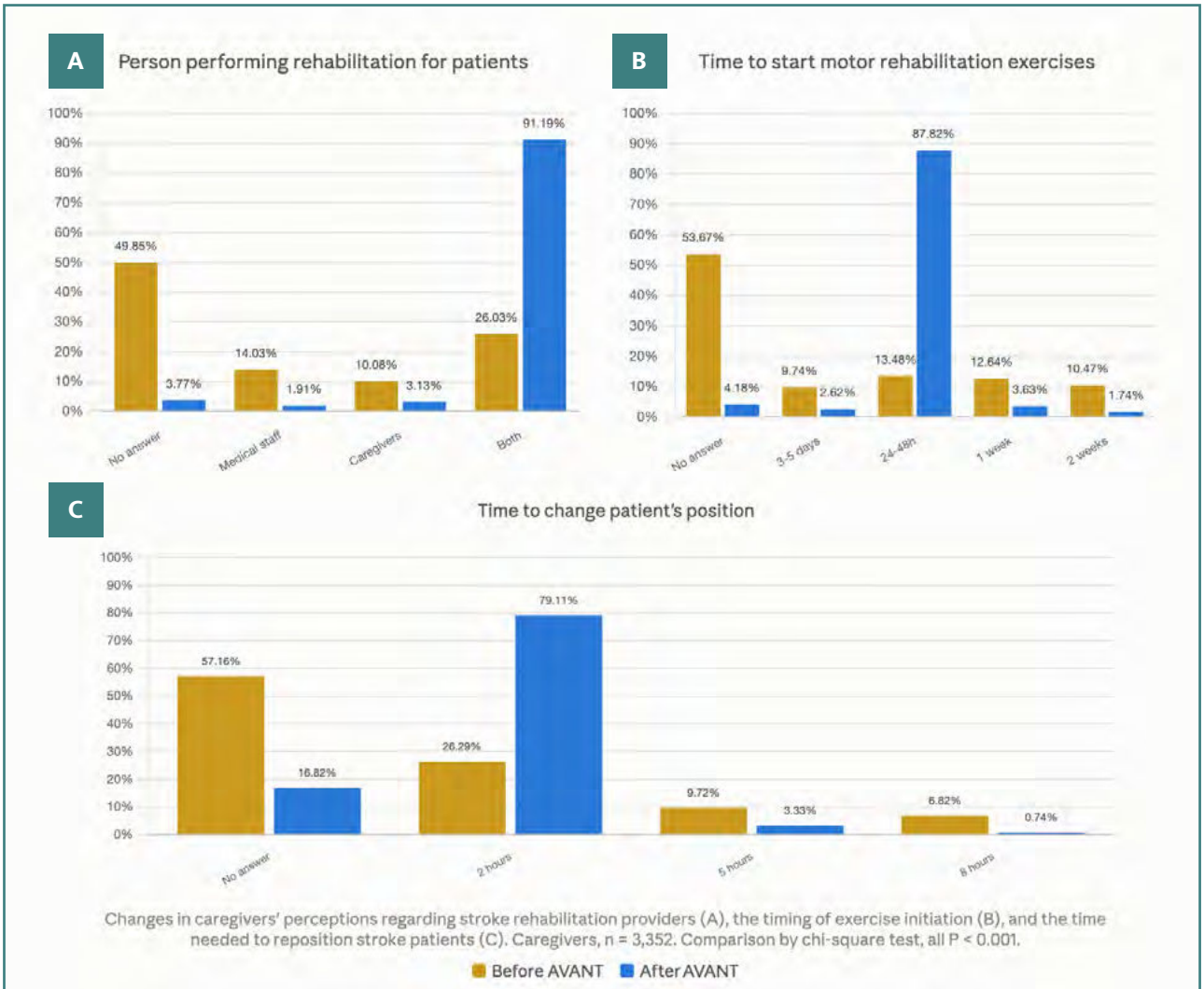



**Figure 4. Changes in caregivers' perceptions of stroke rehabilitation. (A) Rehabilitation providers; (B) timing of exercise initiation; (C) time needed to reposition patients with stroke. Caregivers, *n* = 3352. Comparisons were made using the chi-square test; all *P* < 0.001.**

**Table 7. Caregiver non-responses on stroke prevention before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| Annual health check-ups | 1557 | 46.45% | 87 | 2.60% | *P* < 0.001 |
| Blood pressure control | 1723 | 51.40% | 95 | 2.83% | *P* < 0.001 |
| Blood sugar control | 1925 | 57.45% | 121 | 3.61% | *P* < 0.001 |
| Cholesterol control | 1908 | 56.92% | 130 | 3.88% | *P* < 0.001 |
| Treatment/prevention of CV | 1911 | 57.01% | 151 | 4.50% | *P* < 0.001 |
| Weight loss | 2050 | 61.16% | 209 | 6.24% | *P* < 0.001 |
| Limit alcohol intake | 1886 | 56.26% | 165 | 4.92% | *P* < 0.001 |
| Regular exercises | 1905 | 56.83% | 176 | 5.25% | *P* < 0.001 |
| Avoid stress | 2036 | 60.74% | 235 | 7.01% | *P* < 0.001 |
| Take one special medicine only | 2217 | 66.14% | 267 | 7.97% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment; CV, cardiovascular. Caregivers, *n* = 3,352. Comparisons were made using the chi-square test.



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**Table 8. Caregiver perceptions of post-stroke rehabilitation before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| **Who should perform rehabilitation exercises** | | | | | |
| Medical staff only | 483 | 14.41% | 66 | 1.97% | *P* < 0.001 |
| Caregivers only | 347 | 10.35% | 108 | 3.22% | *P* < 0.001 |
| Medical staff AND caregivers | 896 | 26.73% | 3145 | 93.83% | *P* < 0.001 |
| No answer | 1716 | 51.19% | 130 | 3.88% | *P* < 0.001 |
| **Should stroke patients do rehabilitation exercises** | | | | | |
| NO | 757 | 22.58% | 78 | 2.33% | *P* < 0.001 |
| YES | 1243 | 37.08% | 3162 | 94.33% | *P* < 0.001 |
| No answer | 1352 | 40.33% | 112 | 3.34% | *P* < 0.001 |
| **Impact of rehabilitation exercises** | | | | | |
| Recover motor functions (PT) | 399 | 11.90% | 111 | 3.31% | *P* < 0.001 |
| Daily activities independently (OT) | 315 | 9.40% | 67 | 2.00% | *P* < 0.001 |
| Improve speech/comprehension | 301 | 8.98% | 33 | 0.98% | *P* < 0.001 |
| Safe and comfortable eating | 168 | 5.01% | 23 | 0.69% | *P* < 0.001 |
| All of the above | 663 | 19.78% | 3099 | 92.45% | *P* < 0.001 |
| No answer | 1798 | 53.64% | 108 | 3.22% | *P* < 0.001 |
| **When to start motor rehabilitation** | | | | | |
| After 3–5 days | 336 | 9.74% | 90 | 2.62% | *P* < 0.001 |
| Within 24–48 h (if doctor allows) | 465 | 13.48% | 3022 | 87.82% | *P* < 0.001 |
| After 1 week (when stable) | 436 | 12.64% | 125 | 3.63% | *P* < 0.001 |
| After 2 weeks / post-discharge | 361 | 10.47% | 60 | 1.74% | *P* < 0.001 |
| No answer | 1851 | 53.67% | 144 | 4.18% | *P* < 0.001 |
| **Does the unparalyzed side need practice** | | | | | |
| NO | 771 | 24.46% | 1101 | 32.85% | *P* < 0.001 |
| YES | 960 | 30.46% | 2126 | 63.42% | *P* < 0.001 |
| No answer | 1421 | 45.08% | 125 | 3.73% | *P* < 0.001 |
| **A paralyzed patient should lie only on the back or the healthy side** | | | | | |
| TRUE (incorrect belief) | 1448 | 43.19% | 953 | 28.42% | *P* < 0.001 |
| FALSE (correct) | 406 | 12.11% | 2261 | 67.43% | *P* < 0.001 |
| No answer | 1499 | 44.71% | 139 | 4.15% | *P* < 0.001 |
| **How often should the patient be repositioned** | | | | | |
| Once every 2 hours | 914 | 27.27% | 2662 | 79.42% | *P* < 0.001 |
| Once every 5 hours | 338 | 10.08% | 112 | 3.34% | *P* < 0.001 |
| Once every 8 hours | 237 | 7.07% | 25 | 0.75% | *P* < 0.001 |
| No answer | 1987 | 59.28% | 566 | 16.89% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment; OT, occupational therapy; PT, physical therapy. Comparisons were made using the chi-square test.



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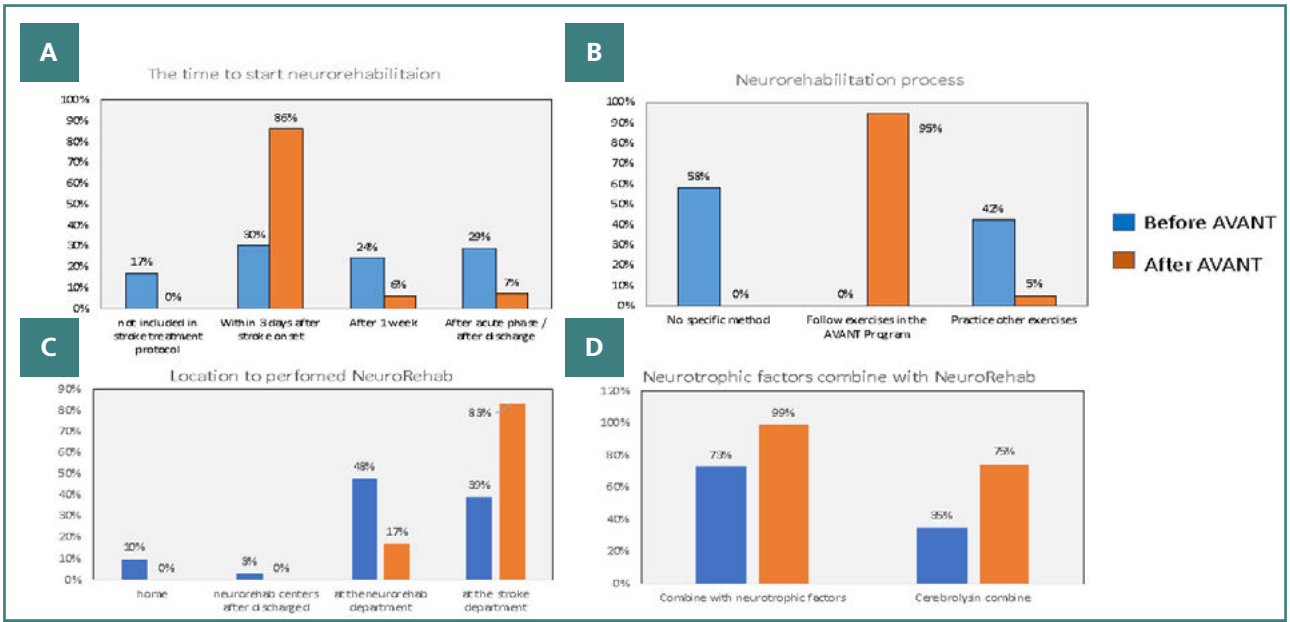



**Figure 5. Stroke-unit practice before and after the AVANT program. (A) Timing of neurorehabilitation; (B) rehabilitation method used; (C) location of delivery; (D) combination with neurotrophic agents. Stroke units, *n* = 96.**

similarly. Correct identification of safe eating position (sitting rather than lying), head posture (chin lowered), and head orientation (turned to the paralyzed side) rose from 40.29%, 33.27%, and 19.03% before training to 64.20%, 58.54%, and 53.00% after training, respectively. At the same time, recognition of soft, pudding-textured food as appropriate for patients with swallowing difficulty increased from 9.97% to 62.79% (Table 9). Non-response rates on these items also fell sharply, from over 40% before training to under 5% after (Table 9).

## DISCUSSION

The present study demonstrates that the AVANT program has been an effective educational intervention to strengthen stroke rehabilitation awareness and practices in Vietnam. Before the program's implementation, both caregivers and healthcare professionals exhibited significant knowledge gaps regarding stroke prevention, recognition, and rehabilitation. The AVANT program addressed many of these shortcomings, producing measurable gains in understanding, behavior, and clinical application. These findings highlight that structured educational initiatives can play a pivotal role in improving post-stroke recovery outcomes in low- and middle-income settings.

### Baseline gaps in awareness and practice

Before AVANT, misconceptions about stroke were widespread in the Vietnamese community. Traditional first-aid methods such as Gua Sha (skin scraping) and fingertip bloodletting remained common, and few respondents identified calling emergency services as the appropriate first response (Table 3). These misconceptions mirror findings from other developing countries, where cultural habits and limited access to health education impede timely recognition and emergency care [14].

Among healthcare professionals, variation in baseline knowledge reflected the uneven distribution of specialized stroke care across regions. While the number of certified stroke units has expanded rapidly in Vietnam, integration of early and structured rehabilitation remains inconsistent. Rehabilitation often begins late or is fragmented between departments, delaying neural recovery and increasing the risk of complications such as aspiration pneumonia, pressure ulcers, and muscle contractures [15].

### Impact of the AVANT program

The AVANT program demonstrated significant improvements in both knowledge and applied practice. Among caregivers, the rate of correct emergency response increased more than threefold, and reliance on unscientific traditional treatments dropped sharply. This change is particularly important because caregivers often serve as first responders in Vietnam, where pre-hospital emergency systems are still developing. Improved knowledge of correct positioning, aspiration prevention, and early mobilization directly influences patient recovery and quality of life.

Among healthcare professionals, the proportion of departments with no specific rehabilitation method fell from 58% to 0%, while 95% followed AVANT-specified exercises after training, indicating both successful knowledge transfer and behavioral change within clinical teams. The improved awareness of combining rehabilitation with neurotrophic support, such as Cerebrolysin, is consistent with the European Academy of Neurology and European Federation of NeuroRehabilitation Societies (EAN/EFNR) guideline, which recommends Cerebrolysin as pharmacological support for early motor rehabilitation after acute ischemic stroke and reflects established practice in several European countries [16]. As this study did not directly evaluate Cerebrolysin's efficacy or patient-level neurorecovery outcomes, this finding should be interpreted as improved decision-making among clinicians rather than evidence of a treatment effect. Importantly, AVANT encouraged a multidisciplinary approach linking neurologists, physiotherapists, and rehabilitation specialists, which is essential for sustainable outcome improvements.



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**Table 9. Caregiver knowledge of rehabilitation technique and aspiration prevention before and after the AVANT program**

| Measure | Before AVANT | | After AVANT | | *P* |
|---|---|---|---|---|---|
| | *n* | % | *n* | % | |
| **Rehabilitation technique** | | | | | |
| Do not put weight on paralyzed arm/leg | 750 | 22.37% | 2456 | 73.27% | *P* < 0.001 |
| Paralyzed side: passive exercises only | 1021 | 30.46% | 2225 | 66.38% | *P* < 0.001 |
| Put sleeve on paralyzed side first | 726 | 21.66% | 2944 | 87.83% | *P* < 0.001 |
| Walk up stairs: paralyzed leg first | 1086 | 32.40% | 2591 | 77.30% | *P* < 0.001 |
| Walk down stairs: paralyzed leg first | 424 | 12.65% | 1767 | 52.71% | *P* < 0.001 |
| **Body position while eating** | | | | | |
| Lying | 581 | 17.33% | 1092 | 32.58% | *P* < 0.01 |
| Sitting | 1351 | 40.29% | 2152 | 64.20% | *P* < 0.01 |
| No answer | 1421 | 42.38% | 108 | 3.22% | *P* < 0.001 |
| **Head position while eating** | | | | | |
| Head looking up (chin up) | 763 | 22.75% | 1263 | 37.67% | *P* < 0.001 |
| Chin lowered / head looking down | 1116 | 33.27% | 1963 | 58.54% | *P* < 0.001 |
| No answer | 1475 | 43.98% | 127 | 3.79% | *P* < 0.001 |
| **Head rotation while eating** | | | | | |
| Head turned to paralyzed side | 638 | 19.03% | 1777 | 53.00% | *P* < 0.001 |
| Head turned to healthy side | 1078 | 32.15% | 1398 | 41.69% | *P* < 0.001 |
| No answer | 1637 | 48.82% | 178 | 5.31% | *P* < 0.001 |
| **Food texture for swallowing disorder** | | | | | |
| Liquid food | 920 | 27.45% | 1098 | 32.76% | *P* < 0.001 |
| Soft food (pudding texture) | 336 | 10.02% | 2119 | 63.21% | *P* < 0.001 |
| Solid food | 82 | 2.45% | 22 | 0.66% | *P* < 0.001 |
| No answer | 2032 | 60.62% | 136 | 4.06% | *P* < 0.001 |

AVANT, Austrian Vietnamese Advancement Neurorehabilitation Treatment. Caregivers, *n* = 3,352. Comparisons were made using the chi-square test.

## Comparison with other educational models

Educational programs targeting stroke awareness have shown encouraging but variable results elsewhere in the region. In South India, a school- and college-based community education program significantly improved recognition of stroke signs and reduced reliance on traditional remedies as an initial response. However, the intervention targeted general public awareness rather than caregivers of stroke patients specifically [14]. More broadly, stroke education and prehospital response programs in other low- and middle-income countries have shown similar knowledge gains, though sustained integration into clinical practice remains a common challenge, particularly where pre-hospital emergency systems are still developing [17]. Compared with these programs, AVANT combined dual-targeted training, addressing both professionals and caregivers, within a standardized, Ministry of Health–approved curriculum delivered consistently across multiple sites, which may explain its broad reach.

## Remaining challenges

Despite these achievements, several challenges persist. First, heterogeneity in baseline education levels among caregivers limited the depth of knowledge acquisition for some participants. Rural and remote areas continue to have fewer trained rehabilitation professionals, and follow-up supervision after training remains limited. Extending AVANT's duration or introducing refresher courses could help maintain gains over time.

Second, many hospitals have not fully integrated rehabilitation protocols into stroke unit workflows. Structural barriers, such as shortages of physiotherapists, lack of dedicated space, and inconsistent use of standardized outcome measures, continue to hinder progress. Moreover, societal attitudes toward disability and reliance on family-based care may delay patients' return to structured therapy programs [18].

Third, while AVANT primarily addressed motor recovery and included basic caregiver-level awareness of aspiration-prevention



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practices, other highly prevalent post-stroke complications, such as formal dysphagia screening and management, aphasia, cognitive deficits, and occupational therapy needs, were beyond its initial scope.

### Implications for future programs

The outcomes of this study suggest the feasibility of targeted, scalable educational interventions for stroke rehabilitation. The results support launching an expanded AVANT II project that builds on the current foundation while addressing additional domains of post-stroke dysfunction. AVANT II should incorporate specialized modules on swallowing rehabilitation, communication therapy, cognitive retraining, and activities of daily living.

Digital learning tools and tele-rehabilitation could also expand reach, especially in underserved rural areas. Integration with national stroke care networks and ongoing collaboration between Vietnamese and international rehabilitation experts would ensure sustainability.

### Strengths and limitations

A major strength of this study is its large, multicenter sample, which includes both healthcare professionals and lay caregivers, allowing a comprehensive assessment of stroke awareness. Additionally, the program's dual training design allowed evaluation of knowledge transfer at both clinical and community levels.

However, several limitations warrant acknowledgment. The observational design lacked a control group, limiting causal inference. The study did not systematically record caregiver recruitment, participation, and refusal rates, precluding assessment of potential selection bias. Self-reported data may introduce response bias; in addition, the Class A and Class B questionnaires were newly developed for this program and pilot tested, but did not undergo formal reliability or validity testing. Department-level practice indicators reported by Class A representatives were based on self-estimation by a single representative per department rather than independent audit, which may be subject to recall or estimation bias. Future studies should incorporate validated instruments, formal psychometric evaluation, and objective practice audits where feasible, as well as longitudinal follow-up to assess whether knowledge improvements translate into sustained behavior change and better patient outcomes. In addition, denominators varied across individual survey items because respondents could leave any question unanswered, which should be considered when interpreting item-level percentages.

## CONCLUSION

This study suggests that the AVANT program is associated with meaningful improvements in stroke-related knowledge, attitudes, and self-reported practices among healthcare professionals and caregivers in Vietnam. Participants showed clearer understanding of early rehabilitation timing, basic positioning and aspiration-prevention practices, and a marked reduction in reliance on unscientific traditional practices. Given the observational, single-arm design of this study, these findings should be interpreted as an association between AVANT participation and improved knowledge and practice, rather than definitive proof of the program's effectiveness in changing patient outcomes; no direct measures of patient functional recovery, disability, quality of life, or long-term reintegration were collected.

The current AVANT program focused on motor recovery and included basic caregiver-level awareness of aspiration-prevention practices. Other common post-stroke complications, including formal dysphagia screening and management, aphasia, and cognitive impairment, were outside its scope and remain important gaps in stroke rehabilitation education in Vietnam. Building on the knowledge gains described in this manuscript, an AVANT II initiative is planned to extend training into these areas and to incorporate digital and tele-rehabilitation formats to reach rural and underserved regions. Future work should include a control group and direct patient outcome measures to evaluate the program's impact on stroke recovery more rigorously.

### Conflict of interest

EVER Neuro Pharma Asia Ltd. organized and funded the AVANT training program. Dr. Hoang Anh Le is the Country Director of EVER Neuro Pharma Asia Ltd. in Vietnam and contributed to the design and conduct of the AVANT program and this study. The remaining authors declare no conflict of interest.

### Ethical approval

No institutional ethics committee or other regulatory body was consulted for this study. The study team determined that formal ethics committee review was not required, as this was a routine, anonymized evaluation of an existing educational and quality improvement program (the AVANT training program) involving no clinical intervention, no alteration of patient care, and no collection of identifiable patient information. The study was conducted in accordance with the Declaration of Helsinki.

### Consent to participate

All participants were informed of the purpose and voluntary, anonymous nature of the survey before completing the questionnaire, and participation implied consent.

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This work was funded by EVER Neuro Pharma Asia Ltd., which organized and financed the AVANT program.

### Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

### Personal thanks

The authors acknowledge the Vietnam Stroke Association, the World Stroke Organization, and participating hospitals for their support and collaboration in implementing the AVANT program.

### Use of artificial intelligence

During the preparation of this work, the authors used ChatGPT to enhance the language and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

### Authorship

TVN contributed to investigation, data curation, and writing – original draft. LQN contributed to investigation, formal analysis,



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data curation, and writing – review and editing. NHN contributed to investigation, project administration, and writing – review and editing. HAL contributed to conceptualization, funding acquisition, supervision, and writing – review and editing. AW contributed to conceptualization, methodology, writing – original draft, and writing – review and editing.

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