Improving Stroke Care Access With a Mobile Stroke Unit: Evidence From a Community Hospital in Southern Thailand

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Abstract

Background: Stroke is a critical public health issue in Thailand, where timely treatment is essential but often remains unmet. This study evaluated the impact of a Mobile Stroke Unit (MSU) at Cha-uat Hospital, a community hospital. We examined its effect on stroke care access, diagnosis, and overall outcomes across three distinct phases: before MSU implementation, during its initial operation, and after it was fully established.
Methods: This multiple cross-sectional study analysed data from 478 stroke patients. Patients were grouped into three periods: 116 before MSU, 176 during its implementation, and 186 after full operation. Patient data from the hospital's health information systems focused on service access and clinical improvements.
Results: MSU implementation led to a significant increase in overall stroke patient numbers (from 116 to 186) and enhanced diagnosis of ischemic stroke. Crucially, referrals to higher-level hospitals sharply declined (from 116 to 10 cases), indicating effective on-site care. The healthcare network also expanded, providing services to previously unserved community hospitals. However, while timely patient arrivals saw a slight, non-significant improvement (from 46.55% to 49.46%), a major challenge was the continued preference for self-transport over MSU/Emergency Medical Services.
Conclusion: The MSU effectively increased stroke service access, improved early diagnosis, and expanded the healthcare network. Yet, overcoming behavioural barriers to timely access and encouraging emergency transport use remains critical. Further research on cost-effectiveness and influencing factors is recommended to optimize future stroke care delivery.

Keywords: stroke, mobile stroke unit, stroke care access, community hospitals, healthcare network

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Introduction

Stroke is a leading cause of death and disability globally (Feigin et al., 2021), especially in developing countries. Additionally, it is a significant public health issue both globally and in Thailand (Kumluang et al., 2023). It is the second leading cause of death and the third leading cause of disability. Between 2019 and 2023, Thailand saw an increase in the number of new stroke cases, rising from 5.87 to 7.75 per 100,000 people. While incidence increased, the mortality rate for stroke actually decreased from 5.53 to 4.61 per 100,000 during the same period. This trend has major implications for healthcare costs and the overall burden of care (Kim et al., 2020).

Stroke It can be divided into transient ischemic attack (TIA), ischemic stroke (IS), hemorrhagic stroke (HS), and subarachnoid hemorrhage. Acute ischemic stroke (AIS).(Waziry et al., 2020) with ischemic stroke being the most prevalent type.(Kuriakose & Xiao, 2020) Identifying stroke symptoms quickly, often by using the FAST/BEFAST acronym, is essential for ensuring timely treatment (Chen et al., 2022). Therefore, early recognition of stroke is crucial, and using prehospital stroke scales can help identify suspected cases promptly for effective acute treatment (Duvekot et al., 2021). Cha-uat Hospital, a community hospital in southern Thailand serving a population of over 85,968, treats more than 200 stroke patients annually. Despite their efforts, the hospital has consistently struggled to achieve the national target of 80% of patients receiving timely treatment within 4.5 hours. Rates for timely access at Cha-uat Hospital ranged from 44.48% to 60.76% between 2019 and 2023, highlighting ongoing challenges with delayed patient access to care.

To address this critical problem, Cha-uat Hospital launched an Emergency Medical System incorporating a Mobile Stroke Unit (MSU) in 2023. This MSU is designed to provide faster and more effective treatment for stroke patients and extends its services to three nearby districts (Ellens et al., 2022). This study aims to examine how the MSU has affected stroke patients' access to care across three periods: before the MSU's introduction, during its initial operation, and after it became fully implemented. The ultimate goal is to assess how improved access and timely treatment through the MSU system can help reduce mortality, disease severity, and disability among stroke patients.

Methods

This study used a multi-phase approach to look at stroke care, analysing data over an 18-month period. We initially collected information from 551 stroke patients. However, 73 cases were excluded based on specific criteria, leaving 478 patients for our detailed analysis.

The study was structured into three distinct time periods to evaluate the impact of the Mobile Stroke Unit (MSU). Before the MSU was introduced (Pre-MSU implementation), this phase included 116 patients. During the initial phase of MSU operation (Initialling MSU implementation), this period involved 176 patients. After the MSU became fully established and operational (MSU fully Implemented). this final phase included 186 patients.

All patient data were extracted from Cha-uat Hospital's existing health information system. To identify stroke patients, we specifically used ICD-10 codes I60-I69 and G459.This study evaluates the impact of a Mobile Stroke Unit (MSU) on stroke care access in a southern Thailand community hospital. Our main focus was to assess patient access to services. We

used basic descriptive statistics to compare these factors across the three time periods. This methodology allowed us to understand the changes in stroke care access and outcomes after the MSU system was put in place. Ethical approval for the study was obtained from the Human Research Ethics Committees of Thaksin University (COA No. TSU 2024_141, REC No. 0369).

Results

This section details the findings from an 18-month multi-phase cross-sectional study (Yi et al., 2019) on the impact of a Mobile Stroke Unit on stroke care access at Cha-uat Hospital and its network in southern Thailand. The results are presented across several key areas: the demographic characteristics of the patients, the overall trends in service access, changes in stroke diagnosis and referral patterns, the expansion of the service network, the timeliness of care, and patient transportation behaviours.

Demographic Characteristics of Stroke Patients

The study analysed data from 478 stroke patients who met the inclusion criteria. The demographic profile of this sample group revealed several key characteristics.

Overall Sample Description

The patient population was slightly predominantly male, with 55.02% being male and 44.98% being female (Table 1). The average age of stroke patients was 65.97 years, with a standard deviation of 15.15 years, indicating a broad age range within the patient group. This average age highlights that stroke primarily affects an older demographic in this region, which aligns with general stroke epidemiology.

In terms of religious affiliation, the vast majority of participants were Buddhist, accounting for 96.65% (462 individuals) of the sample. This reflects the predominant religious demographic of the region. Regarding occupations, a significant portion of patients were involved in primary industries: agriculture was the primary occupation for 48.53% (232 individuals), followed by general labour at 30.12% (144 individuals), and other occupations making up 15.48% (74 individuals). This occupational distribution suggests that a considerable number of stroke patients in this community are engaged in physically demanding jobs, which could have implications for their health and recovery.

The health history of the patients showed a high prevalence of chronic diseases, which are known risk factors for stroke. The most common underlying conditions were hypertension (24.05% or 115 individuals) and diabetes (16.32% or 78 individuals). Other chronic diseases accounted for 3.97% (19 individuals). These figures underscore the importance of managing chronic conditions within the community to potentially reduce stroke incidence. In terms of health behaviours, a majority of patients reported never smoking (55.23%) and not consuming alcohol (61.92%). This indicates that while chronic diseases are prevalent, lifestyle factors such as smoking and alcohol consumption might be less influential for a substantial portion of this specific stroke population, or that other risk factors are more dominant.

Table 1
Characteristics of Stroke Patients at Cha-uat Hospital

Variable	pre-MSU implementation		during implementation		post-implementation		Total	
	N	%	N	%	N	%	N	%
Gender								
Male	66	13.80	95	19.87	102	21.33	263	55.02
Female	50	10.46	81	16.94	84	17.57	215	44.98
Religion								
Buddhism	115	24.06	167	34.94	180	37.66	462	96.65
Islam	1	0.21	8	1.67	4	0.84	13	2.72
Christianity	-	-	-	-	1	0.21	1	0.21
Other	-	-	1	0.21	1	0.21	2	0.42
occupation								
Not working	4	0.84	-	-	-	-	4	0.84
Student	1	0.21	-	-	2	0.42	3	0.63
Civil servants/ retired employees	2	0.42	2	0.42	1	0.21	5	1.05
Employee	32	6.70	54	11.30	58	12.13	144	30.12
Trade/Private business	6	1.25	3	0.63	7	1.46	16	3.35
Agriculture	64	13.39	83	17.36	85	17.78	232	48.53
Other	7	1.46	34	7.11	33	6.90	74	15.48
Underlying disease								
No underlying diseases	74	15.48	89	18.62	102	21.34	265	55.44
Heart disease	1	0.21	-	-	-	-	1	0.21
Diabetes	15	3.14	37	7.74	26	5.44	78	16.32
Hypertension	21	4.39	43	8.99	51	10.67	115	24.05
Other	5	1.05	7	1.46	7	1.46	19	3.97
Smoking								
Yes	56	11.71	75	15.69	83	17.36	214	44.77
No	60	12.55	101	21.13	103	21.55	264	55.23

Variable	pre-MSU implementation		during implementation		post-implementation		Total	
	N	%	N	%	N	%	N	%
Alcohol								
Yes	48	10.04	61	12.76	73	15.27	182	38.07
No	68	14.22	115	24.06	113	23.64	296	61.92
Chief complaint (B E F A S T)								
Balance	43	3.60	41	3.43	34	2.85	118	9.88
Eye	3	0.25	6	0.50	14	1.17	23	1.93
Face	40	3.35	59	4.94	68	5.70	167	13.99
Arm	93	7.79	154	12.90	141	11.81	388	32.50
Speech	60	5.03	98	8.21	108	9.05	266	22.27
Time	54	4.52	88	7.37	90	7.54	232	19.43

The mean age of patients was 65.97 years (SD = 15.15).

Chief Complaints/Symptoms

When arriving for care, the stroke patients presented with a variety of symptoms, often identifiable using the BEFAST acronym (Table 1). The most frequently reported primary symptom was unilateral limb weakness, affecting 80.75% of patients. This is a classic and highly recognisable sign of stroke, indicating motor impairment on one side of the body. Following this, slurred speech, unclear speech, or difficulty finding words was reported by 55.85% of patients. Facial asymmetry or drooping on one side was observed in 34.93% of cases. These symptoms align with typical presentations of stroke and highlight the critical need for rapid recognition and response to facilitate timely medical intervention.

Demographic Shifts Across Implementation Phases

An examination of patient demographics across the three study periods (pre-MSU, initial MSU implementation, and fully implemented MSU) revealed some shifts.

While males consistently comprised a larger proportion of patients across all phases, the *absolute numbers* of both male and female patients increased. In the pre-MSU phase, there were 66 males and 50 females (Table 1). During implementation, these numbers rose to 95 males and 81 females. Post-MSU implementation saw further increases to 102 males and 84 females. This reflects the overall increase in patient access rather than a significant shift in gender proportion within the stroke population itself.

Patients with underlying diseases were 42 in the pre-MSU phase, increasing significantly to 87 during implementation, and then 84 post-implementation. Conversely, patients with no reported underlying diseases initially increased from 74 to 89, then further to 102. This suggests that the MSU might be reaching a broader group of patients, including those who may or may not have known chronic conditions.

The average age of patients also varied across the phases. Before the MSU, the average age was 68.56 years. This decreased to 64.35 years during the initial implementation phase, suggesting that the MSU was potentially more effective at reaching slightly younger patients who might have a higher likelihood of benefiting from timely intervention. In the post-implementation phase, the average age slightly increased again to 65.87 years. This fluctuation could reflect the evolving reach and integration of the MSU within the broader healthcare system.

Trends in Stroke Patient Access to Services

The implementation of the Mobile Stroke Unit had a notable impact on the overall number of stroke patients accessing services and on diagnostic patterns.

Overall Increase in Patient Numbers

A clear and consistent upward trend in the number of stroke patients accessing services was observed across the three phases of the study. We found that, before MSU implementation, 116 patients received services. During the initial phase of MSU implementation, the number of patients significantly increased to 176. After the MSU became fully operational, the number of patients further increased to 186. This continuous increase indicates that the introduction and establishment of the MSU had a positive impact on service accessibility, effectively expanding opportunities for the public to receive care. This quantitative rise suggests that the MSU was successful in reaching more individuals in need of stroke services within the community and its network. The increase in patient numbers reflects the unit's effectiveness in expanding opportunities and improving public access to services, particularly for those in remote areas who may have previously faced barriers to care.

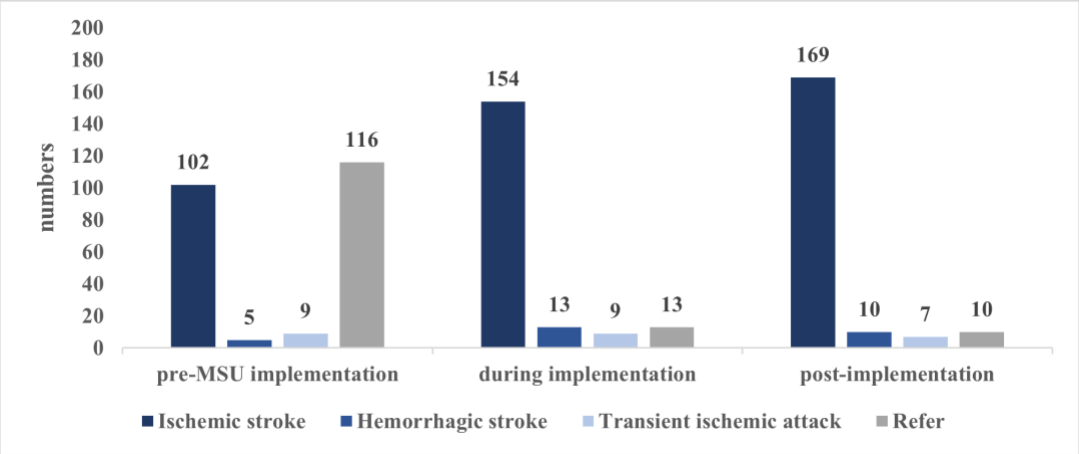
Impact on Patient Demographics During Phases (Average Age)

As noted in the demographic section, the change in average age across the phases is an important observation related to access. The average age of patients decreased during the initial deployment of the MSU, from 68.56 years pre-MSU to 64.35 years during implementation. Although it slightly increased to 65.87 years post-implementation, this initial decrease suggests that the MSU was potentially able to reach younger patients more quickly. This could be a result of improved screening efficiency or more proactive community health campaigns that encouraged earlier presentation for symptoms. Reaching younger patients earlier can be particularly important for long-term outcomes and disability reduction.

Changes in Stroke Type Diagnoses and Referral Patterns

Figure 1 illustrates the distribution of stroke types and referral patterns across the three periods, revealing important insights into the MSU's diagnostic capabilities and impact on hospital burden. The number of patients diagnosed with ischemic stroke showed a continuous increase across all three phases: 102 cases pre-MSU, 154 during implementation, and 169 post-implementations. This consistent rise strongly suggests that the MSU enhanced early and accurate diagnosis of ischemic strokes, leading to more effective initial treatment at the point of care. The MSU's ability to diagnose on-site likely contributed to this improved identification.

Figure 1
Number of Stroke Patients Classified by Type



In contrast to ischemic stroke, the number of patients diagnosed with haemorrhagic stroke and Transient Ischemic Attack (TIA) remained relatively stable, showing only slight variations across the phases. This stability indicates that while the MSU improved the detection of ischemic strokes, it maintained consistent identification of other stroke types.

A significant finding was the drastic reduction in the number of referred cases after the MSU implementation. Referrals decreased from 116 cases pre-MSU to just 13 during implementation, and further to 10 post-implementations. This marked decrease strongly indicates that the MSU was effective in providing on-site diagnosis and initial treatment, thereby reducing the need for patients to be transferred to higher-level healthcare facilities. This reduction in referrals is crucial as it lessens the burden on tertiary hospitals and strengthens the capacity of community hospitals to manage early-stage stroke care directly.

Expansion of Service Network

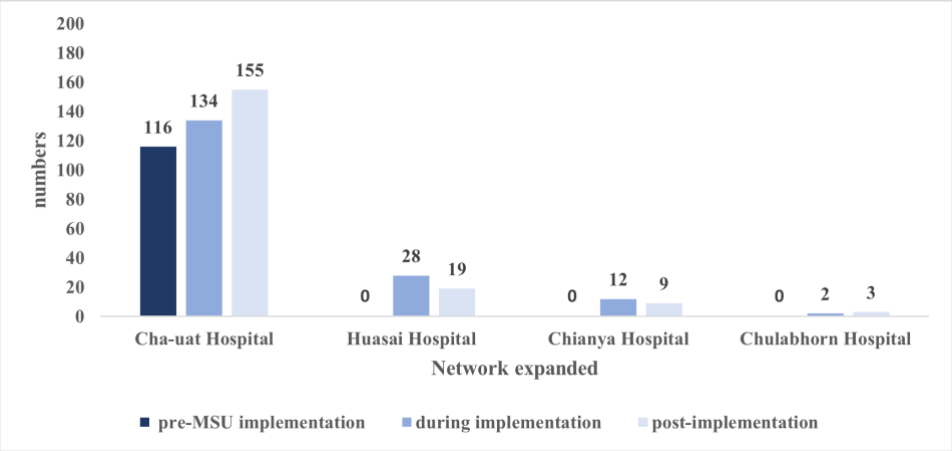
The study provided clear evidence that the MSU operation led to a significant expansion of the stroke service network. Figure 2 illustrates this expansion across Cha-uat Hospital and its network hospitals.

Increased Access at Main Hospital

Cha-uat Hospital, which serves as the main facility in the area, experienced a continuous increase in the number of service recipients. The patient count at Cha-uat Hospital rose from 116 patients before MSU implementation, to 134 during implementation, and further to 155 patients post-implementation. This consistent rise in numbers at the primary hospital directly reflects an increase in access to services within the main service area of Cha-uat Hospital.

Figure 2

Comparison of the Number of Service Recipients in Network Hospitals



New Access in Network Hospitals

A particularly significant outcome of the MSU implementation was its impact on the surrounding network hospitals: Huasai Hospital, Chian Yai Hospital, and Chulabhorn Hospital. Crucially, these hospitals did not provide stroke services before the MSU was implemented. However, with the introduction of the MSU, they started receiving service recipients both during the implementation phase and after the full implementation.

This demonstrates a clear expansion of the service network to secondary hospitals located in more remote areas. The MSU's operations not only increased access at the main hospital but also efficiently extended the reach of stroke care services to these peripheral facilities. This extension of the service network is a testament to the MSU's role in establishing a more comprehensive primary healthcare service network, which is vital for reducing healthcare access disparities among the population, especially for individuals residing in remote communities.

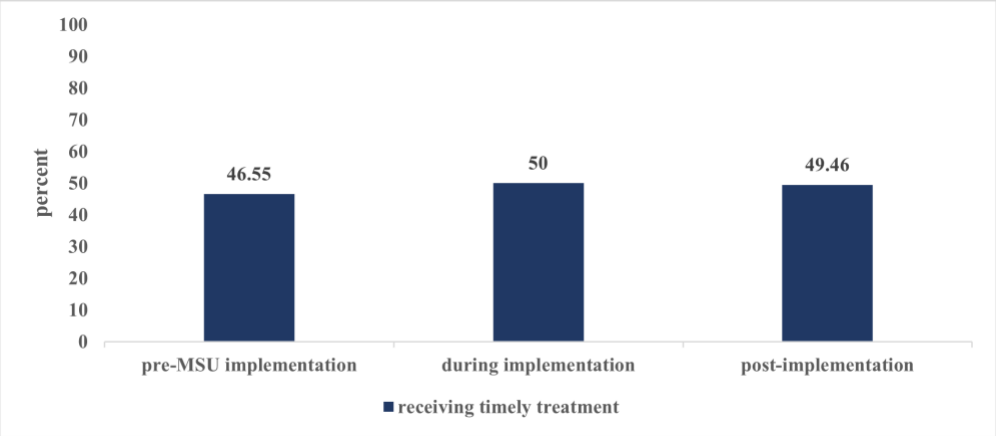
Timeliness of Access to Care

While the overall number of patients accessing care increased substantially, the study also examined the proportion of patients receiving timely treatment, defined as within 4.5 hours.

Proportional Timely Access Across Phases

Figure 3 illustrates the percentage of patients receiving timely treatment across the three study periods. Before the MSU was introduced, 46.55% of patients received timely treatment. During the pilot phase of MSU operation, this proportion increased to 50.0%. During full implementation, the percentage slightly decreased to 49.46%. This indicates a positive trend towards improvement in timely arrivals. The initial increase from 46.55% to 50% during the pilot phase suggests an immediate positive effect of the MSU in facilitating quicker access to care for a greater proportion of patients.

Figure 3
Graph Showing Timely Access to Services Among Stroke Patients



Statistical Significance and Implications

Despite the observed positive trend in timely access, the differences across the periods were not statistically significant. This finding suggests that while the MSU successfully brought more patients into the system, and many of them received care more quickly, the overall percentage of patients reaching the hospital within the crucial 4.5-hour window did not show a statistically robust improvement. The lack of statistical significance indicates that there may still be limitations in patient transport systems or persistent behavioural factors within the population that affect the speed at which patients seek and receive care. This highlights a continuing challenge in achieving the national target of 80% timely treatment and suggests that sustained efforts beyond just the MSU deployment are necessary to overcome these remaining barriers to rapid access.

Patient Transportation Behaviour

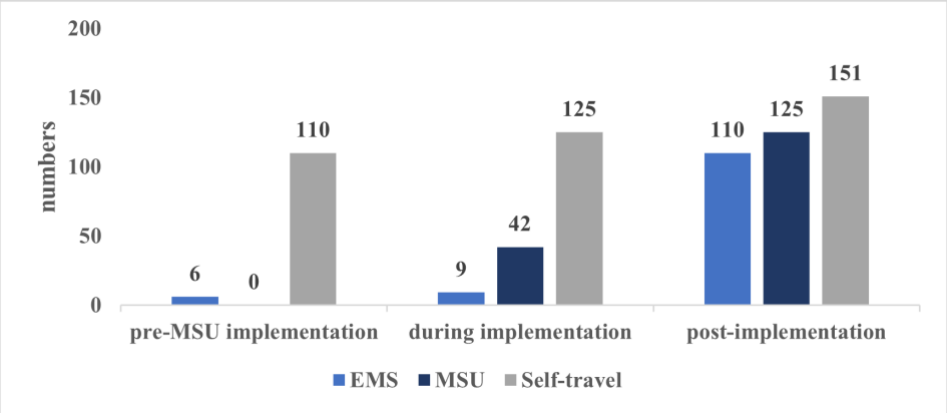
The study also investigated how stroke patients arrived at the hospital, revealing important patterns in transportation choices.

Preferred Mode of Transport

Figure 4 provides a comparison of transportation methods used by patients in the post-implementation period. It was found that a significantly higher number of patients continued to travel to the hospital by themselves. This means patients were arriving via private vehicles, taxis, or other non-emergency means rather than relying on medical transport services. Specifically, the number of patients using self-transport exceeded those using the Mobile Stroke Unit (MSU) by 26 patients and those using Emergency Medical Services (EMS) by 41 patients in the post-implementation phase. Despite the availability and benefits of the MSU and EMS for stroke care, these findings reflect a continuing preference for self-transport among patients.

Figure 4

Access to Healthcare Services Among Stroke Patients



Implications for Service Utilisation and Public Education

This persistent trend of self-transport, despite the increase in MSU use (by 26 patients) and EMS use (by 41 patients) across the phases, highlights a critical area for future intervention. It suggests a need to build greater knowledge, understanding, and public confidence in emergency transport systems. Promoting the use of faster, potentially life-saving services like EMS or the MSU is crucial for maximising the efficiency and effectiveness of stroke care systems at the community level. Overcoming these behavioural patterns through sustained public health campaigns and education could further improve timely access and ultimately patient outcomes.

In summary, the results demonstrate that the MSU significantly increased the total number of stroke patients accessing services and expanded the healthcare network to rural areas. It also led to improved diagnosis of ischemic stroke and a substantial reduction in referrals to higher-level facilities. While there was a positive trend in timely access, this improvement was not statistically significant, and a challenge remains in modifying patient travel behaviours to encourage greater use of emergency medical transport.

Discussion

This study set out to evaluate the impact of a Mobile Stroke Unit on stroke care access in a community hospital in Southern Thailand, specifically Cha-uat Hospital. Our aim was to examine patient access to care across three distinct periods: before the MSU was put into action, during its initial operation, and after it was fully implemented. The ultimate goal was to assess whether the MSU system could reduce mortality, disease severity, and disability among stroke patients by improving access and ensuring more timely treatment, particularly within community hospitals and their wider networks (Mathur et al., 2019).

The results of this 18-month study clearly demonstrate that the implementation of the MSU at Cha-uat Hospital had a significant positive influence on healthcare access for stroke patients, both in terms of the number of people receiving care and the quality of that access. We observed a continuous and encouraging increase in the number of stroke patients seen by the hospital across all three phases: from 116 cases before the MSU was available, rising to 176 cases during its implementation, and further increasing to 186 cases once it was fully operational. This upward trend strongly suggests that introducing the MSU was crucial in

making healthcare more available to the local population, especially those living in rural areas or communities further away from the main hospital.

An interesting finding related to patient demographics was the change in the average age of those receiving services. Initially, during the early phase of the MSU's deployment, the average age of patients decreased from 68.56 years to 64.35 years. While it later slightly increased to 65.87 years post-implementation, this initial decrease suggests that the MSU was potentially able to reach younger stroke patients more quickly. This could be due to more effective screening processes or successful public health campaigns carried out within these communities, encouraging earlier recognition and response to stroke symptoms.

Beyond simply increasing the number of patients, the MSU also appeared to significantly enhance the diagnostic capabilities for stroke patients. We found a clear and continuous increase in the number of patients diagnosed with ischemic stroke from 102 cases pre-MSU, to 154 during implementation, and 169 post-implementation. In contrast, the numbers for hemorrhagic stroke and transient ischemic attack (TIA) remained relatively stable. This indicates that the MSU played a vital role in enabling earlier and more accurate diagnoses, which is critical for providing effective initial treatment right at the point of care. This improved on-site diagnosis and immediate treatment had a remarkable secondary benefit: a substantial reduction in patient referrals to higher-level hospitals. The number of referred cases dropped dramatically from 116 before the MSU, to just 13 during its operation, and then to 10 after full implementation. This significant decrease highlights the MSU's effectiveness in reducing the burden on larger, tertiary hospitals and, crucially, strengthening the capacity of community hospitals like Cha-uat to manage early-stage stroke care more independently.

Furthermore, the study clearly showed that the MSU led to a valuable expansion of the stroke care service network. While Cha-uat Hospital, as the main facility, experienced a continuous increase in its patient numbers, ranging from 116 to 134 to 155, demonstrating improved access in its primary service area, the impact extended beyond its direct doors. Importantly, other network hospitals, including Hua Sai Hospital, Chian Yai Hospital, and Chulabhorn Hospital, which did not provide these services before the MSU, began receiving stroke patients during and after its implementation. This expansion is compelling evidence of the successful establishment of a more comprehensive primary healthcare service network. By extending services to secondary hospitals in more remote areas, the MSU helped to reduce disparities in healthcare access across the population, making essential stroke care available to more people who previously had limited options.

Despite these significant improvements in overall access, diagnosis, and network expansion, the study identified continuing challenges, particularly concerning the timeliness of patient access to care. Although there was a slight increase in the proportion of patients arriving at the hospital within the recommended timeframes from 46.55% before the MSU, to 50.0% during its pilot phase, and 49.46% during full implementation this difference was not found to be statistically significant. This lack of substantial improvement in timely arrivals suggests that there may be ongoing limitations within patient transport systems or persistent behavioural factors within the population that hinder quick access to care. These issues indicate that ongoing efforts in health promotion and education are needed to overcome these barriers.

Another notable finding related to patient behaviour was that a significantly higher number of patients continued to prefer travelling to the hospital by themselves. This preference persisted even compared to those who utilised the MSU or standard Emergency Medical Services (EMS). While there was a slight increase in the use of MSU services by 26 patients and EMS by 41 patients, the findings underscore a critical need to build greater knowledge, understanding, and public confidence in emergency transport systems. Promoting the use of faster, life-saving services like EMS or the MSU is essential, as prompt transportation can significantly improve stroke outcomes. This highlights that simply providing the service is not enough; public awareness and trust are equally vital for maximising its effectiveness.

In conclusion, the establishment of the Mobile Stroke Unit has undeniably been effective in increasing access to stroke services, enabling faster and more accurate diagnoses, reducing the need for patient referrals to higher-level facilities, and successfully expanding public health service networks into remote areas. These are crucial steps forward in improving stroke care at the community level. However, challenges remain, particularly in modifying long-standing patient behaviours and achieving a statistically significant improvement in timely access to care. Addressing these persistent issues will require sustained, targeted efforts to educate the public and continuously optimise service delivery. Further research is also recommended to evaluate the cost-effectiveness of the MSU, to investigate other factors affecting access across diverse population groups, and to further refine and optimise the delivery of these vital services.

Conclusion (Limitations, and Implications)

The implementation of the Mobile Stroke Unit at Cha-uat Hospital significantly enhanced stroke care access, leading to a substantial increase in the total number of patients receiving services. This initiative also enabled faster and more accurate diagnoses of ischemic stroke, while remarkably reducing the need to refer patients to larger, higher-level hospitals. A key success was the expansion of the stroke care network, extending vital services to other, previously unserved network hospitals and thereby improving access for people in remote areas.

However, the study identified important limitations. Although there was an increase in the proportion of patients receiving timely treatment, this improvement was not statistically significant. This suggests persistent challenges in the speed of access. Furthermore, a significant number of patients continued to prefer travelling to the hospital independently, rather than utilising the quicker MSU or Emergency Medical Services (EMS).

The implications of these findings are clear: while the MSU effectively expands access and improves early diagnosis, ongoing public health education is crucial to address patient behavioural factors and ensure more timely care. For future planning, further research is recommended to evaluate the MSU's cost-effectiveness, explore other influences on access across diverse groups, and continually refine how these essential services are delivered.

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