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Highlight

- Original Article
- Case Report
- Pictorial Essay
- Perspectives
- ASEAN Movement in Radiology
- Memorial

Official Journal of The

Royal College of Radiologists of Thailand

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Thai Society of Vascular and Intervention Radiology

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From The Editor

50 years after 1975

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Misconceptions kill more than any diseases or disasters can ever do. In a universal point of view, basic requirements in any communities include food and life security, property protection, free trading, and the rights to speak and practice faith they believe in. However, power tends to corrupt, and citizens are always the helpless victims. People in the Southeast Asian countries are still struggling to live better lives.

Like borders between many countries in Asia, the 800-kilometer Thai-Cambodian border has long been a source of conflict, often flaring into disputes over territory ownership. The roots of these issues can be traced back to colonial-era borders, with ambiguities and claims leading to periodic tensions leading to significant casualties and displacements among local communities living near the border Lately, the tensions were reignited in May when a Cambodian soldier carrying weapons approaching the Thai defensive line was killed. At approximately 08:20 on 24 July 2025, Cambodian forces opened fire from their position across the eastern side of the Thai base. Without warning, long-distant rockets from Cambodia fell on residential areas of a province on the Thai side causing destruction of a hospital and a convenient store in a gas station immediately killing eight civilians including a mother with her two children in a convenient store. Attacks in other three provinces along the border on the same day killed another three civilians including an 8-year-old boy, and a soldier. After four days of fire which displaced more than 100,000 people in four provinces of Northeastern Thailand to nearly 300 temporary shelters and significant soldiers of both sides were killed, both countries agreed to ceasefire and signed a comprehensive mutual agreement on 7 August 2025 in Putrajaya, Malaysia. To ensure the safety of the local communities along the border, Thailand closed the border to prevent threat of violence from Cambodian soldiers. However, the closure of the border has caused severe disruption of the cross-border business, healthcare, and education system.

Since the 14th century, countless people's lives in continental Southeast Asia were claimed because of political and military conflicts between feudal states in Burma (today Myanmar), Laos, Cambodia, Vietnam, Siam (today Thailand), and Malaya (today Malaysia and Singapore). British colonization of Myanmar and Malaya and French colonization of Laos, Cambodia, and Vietnam during 19th century forced Siam to keep busy adopting the concepts of the nation state, restructuring its loosely feudal state to the single centralized governing body that exercised power over a clearly defined borders. Balancing powers between British and French empires and Siamese government ceased wars between feudal states creating peace in this region for a while.

From left: Young Khmer Rouge soldiers entering Phnom Penh on April 17, 1975 [1]; On 29 April 1975, one day before the fall of Saigon, civilians climbed over the wall of the U.S. Ambassy to reach evacuation helicopters [2]; an officer helped evacuees up a ladder on a helicopter [3].

In the 20th century, the second world war and Japanese invasion helped release Myanmar and Malaya from British colonization, Loas, Cambodia, and Vietnam from French colonization, and Indonesia from Dutch colonization, with the cost of many lives in all Southeast Asian countries. Post second world war establishments of modern countries were progressive and successful in marine Southeast Asian countries. However, in continental Southeast Asian counties, the post second world war vacuum was filled with proxy wars between the free world and communism, which lasted more than 20 years and killed even more people, especially in the outrageous Vietnamese and Laotian wars. In 1975, when democratic governments, with support from the United States of America, were defeated and communism was fully established in Cambodia and Vietnam in April, and Laos in December in the same year with assistance from Soviet Union and People's Republic of China, it did not help build trust and peace in these three communistic countries, mainly because of the national borders, the political concepts of founding the Federation of Indochina (adopted from French Indochina during French colonization but under a single communistic government), and the conflicts between Soviet Union and People's Republic of China. The falls of Saigon, Phnom Pehn, and Vientiane in 1975 along with the subsequent Vietnamese invasions into Cambodia and Laos to form Federation of Indochina, forced formal diplomatic relations between People's Republic of China and Thailand in 1975 followed by the Sino-Vietnamese war in 1979. It is depressing note that the weapons made in China, Soviet Union, and the United States of America were used by Southeast Asian people to kill other Southeast Asian people. During more than 10 years of conflicts, at least 1.5 million Cambodians were killed by people in their own nations during the Khmer Rouge regime. More than 350, 000 people from Laos and 700, 000 people from Cambodia were displaced to the Thailand's northeastern and eastern borders. Around 800,000 people fled Vietnam by boats and ships to Hongkong, Southern Thailand, Malaysia, Singapore, Indonesia and the Philippines while around 200, 000 people died at sea. This regional tragedy from political turmoil happened in just 50 years ago. Katsumi Tsujioka, a junior radiological technologist and Japanese health volunteer at the field hospital, who witnessed the displaced people from Cambodia to the eastern border of Thailand will share his tragic memories with us on this issue on pages 240-251. In Figure 8 on page 245, which refers to an event taking place in 1980, it is depressing that we still recently witness Thai soldiers losing their legs to landmines planted in Thai ground by Cambodian soldiers, even though both countries had ratified the Ottawa Mine Ban Treaty in 1997.

A photo of a Cambodian man with his new prosthetic limb after losing his leg to a landmine during emigration to Thailand in 1980, taken by Katsumi Tsujioka [4]; his smile reflects happiness and confidence that come from feeling safe, protected and properly cared for in a refugee camp in Thailand.

To eliminate poverty, elevate education, and remain a part of free world, Thailand set up two universities in the remote provinces in 1960s: Kon Kaen University in the northeast and Prince of Songkla University in the deep south. This issue continues to keep Associate Professor Chongdee Sukthomya, the first radiologist of Southern Thailand who laid the groundwork for the radiological care and education at Prince of Songkla University in 1975, present in our thoughts.

Nevertheless, hope springs eternal. This issue describes how Thailand implements the AI-assisted system to interpret chest radiographs in public hospitals with the hope of improving health and strengthening Infection Prevention and Control in radiology departments.

Wiwatana Tanomkiat, M.D.
Editor,
The ASEAN Journal of Radiology
Email: aseanjournalradiology@gmail.com

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Original Article

Clinical outcomes of mechanical thrombectomy for acute ischemic stroke with large vessel occlusion: Insights from an Eastern Thailand mechanical thrombectomy center

Wittawat Takong, M.D.[1]
Nattakarn Buranakul, M.D.[1]
Sirinat Puengcharoen, M.D.[1]
Benjamas Boonyawan, R.N.[1]
Warut Chaiwong, M.P.H.[2]
From [1]Neuroscience Center, Bangkok Pattaya Hospital, Chonburi, Thailand,
[2]BDMS Health Research Center Department, Bangkok Dusit Medical Services PCL, Bangkok, Thailand.
Address correspondence to W.T. (email: atitaya.sa@bdms.co.th)

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Abstract

Background: Mechanical thrombectomy (MT) is the standard treatment for acute ischemic stroke with large-vessel occlusion (LVO), but regional data from Thailand are limited, particularly regarding factors influencing long-term outcomes.

Objective: To evaluate 90-day functional independence (modified Rankin Scale [mRS] ≤2) after MT at a single center in Eastern Thailand and identify predictors of functional independence.

Materials and Methods: We retrospectively analyzed all MT procedures from March 2019 to December 2023 at Bangkok Pattaya Hospital. Inclusion followed AHA guidelines and DAWN criteria, with adjustments for early presentations. Baseline demographics, imaging, angiography, and procedural data were collected. The primary endpoint was functional independence at 90 days. Associations were examined using univariate and multivariable logistic regression.

Results: Of 141 MT cases, 132 were included (mean age 64.2 years; 87.8% Thai). Anterior circulation strokes accounted for 87.9%. Successful reperfusion (mTICI ≥2b) occurred in 81.1%, and functional independence at 90 days in 70.5%. Lower baseline NIHSS showed borderline association with functional independence (p=0.059). Post-procedural aICH or no ICH significantly reduced odds of functional independence compared with sICH (aICH: OR 0.09, 95% CI 0.02-0.45, p=0.006; no ICH: OR 0.05, 95% CI 0.01-0.20, p<0.001). Age, sex, atrial fibrillation, onset-to-recanalization time, and first-pass success were not significant predictors. sICH was more frequent with IVT+MT than MT alone (17.4% vs. 1.6%, p=0.006).

Conclusion: MT at our center achieved high reperfusion and functional independence rates comparable to international benchmarks. Hemorrhagic transformation was a strong predictor, whereas age, sex, and treatment strategy were not. Careful imaging selection and individualized bridging therapy may optimize outcomes.

Keywords: Acute ischemic stroke, Clinical factor, Mechanical thrombectomy.

Introduction

Stroke continues to pose a significant global health burden. According to the 2025 World Stroke Organization Global Factsheet, it remains the world's second leading cause of mortality—responsible for approximately 7 million deaths per year—and, when accounting for both mortality and morbidity, ranks third overall, contributing to upwards of 160 million DALYs annually [1,2]. Thailand's Ministry of Public Health reports that stroke accounts for around 50,000 deaths per year, ranking as the leading cause of death nationally [3].

Large vessel occlusion (LVO) refers to the blockage of the major proximal cerebral arteries and, when including both the A2 and P2 segments of the anterior and posterior cerebral arteries, is present in approximately 24-46% of acute ischemic stroke cases [4]. Because LVO typically carries a poor prognosis, intravenous thrombolysis (IVT) alone often fails to restore patency—in many cohorts, successful recanalization rates with IVT alone have been reported to be as low as around 20 percent [5-8].

Guidelines updated in 2018 established mechanical thrombectomy (MT) as the standard of care for patients with acute ischemic stroke due to LVO [9]. Although prognostic factors differ among studies, commonly reported variables include patient age, baseline stroke severity assessed with the NIHSS, the site of arterial occlusion (e.g., ICA, M1, or M2 segments of the MCA), administration of IVT, initial Alberta Stroke Program Early CT Score (ASPECTS), and onset-to-treatment time [10].

Thailand's first MT procedures were performed at Siriraj Hospital in 2009. Reported results included a 92.7 % rate of successful recanalization (modified Thrombolysis in Cerebral Infarction, mTICI 2b-3) and 34.15 % of patients achieving functional independence (modified Rankin Scale, mRS ≤2) at an average follow-up of 16 months [11]. At the Prasat Neurological Institute, 90-day outcomes showed an 85 % recanalization rate and a 53 % rate of functional independence [12]. In 2019, Bangkok Pattaya Hospital became the first center in Eastern Thailand to offer MT, and has since seen rapid growth in case volume alongside encouraging patient outcomes. This study reviews MT performance at this center and examines factors influencing patient prognosis.

The objective of this study was to evaluate the clinical outcomes of MT performed at Bangkok Pattaya Hospital, focusing on the rate of functional independence (mRS ≤2) at 90 days post-stroke. Additionally, we aimed to identify factors influencing successful outcomes, including imaging characteristics, procedural success rates, and the impact of complications such as intracranial hemorrhage (ICH).

Materials and methods

This study included all patients who underwent mechanical thrombectomy (MT) at Bangkok Pattaya Hospital between March 2019 and December 2023, excluding those with incomplete medical records. MT was performed within 24 hours of symptoms, following the recommendations outlined in the 2019 American Heart Association (AHA) guidelines [13].

Eligibility criteria were adapted from the AHA guideline recommendations and included:

- Age >18 years,
- Large vessel occlusion (LVO) involving the internal carotid artery (ICA) or M1 segment of the middle cerebral artery (MCA),
- ASPECTS. >6 or clinical-imaging mismatch per the DAWN trial criteria [14] for anterior circulation strokes or presentation in the very early window with no FLAIR hyperintensity on MRI,
- Diffusion-weighted imaging (DWI) brainstem score (BSS) ≤3 for posterior circulation LVO [15].

While the protocol adhered closely to the AHA guidelines, strict compliance with DAWN trial imaging criteria for anterior circulation strokes was achieved in 93.2% of cases. The remaining 6.8% underwent MT despite not meeting DAWN criteria due to early presentation with negative FLAIR sequences, which suggested minimal established infarction. These patients were treated at the discretion of the stroke team, based on clinical judgment and favorable imaging findings, reflecting real-world practice patterns.

Neuroimaging was performed using either a Philips Ingenuity Core-128 CT scanner or a Philips Ingenia 3.0 T MRI system. For patients arriving within 4.5 hours of symptom onset, the initial study was a non-contrast CT (NCCT) of the brain (axial slice thickness 2 mm; multiplanar reconstructions 3 mm), followed by CT angiography (CTA) from the aortic arch to the vertex. CTA acquisition parameters included a 1 mm collimation, 0.5 mm reconstruction interval, 120 kVp tube voltage, 400 mAs tube current, and automated exposure control. A 100 mL bolus of non-ionic iodinated contrast was administered through an 18-20 G peripheral line at 4-4.5 mL/s, followed by a 50 mL saline chaser; bolus tracking was initiated when contrast reached a pre-defined region of interest in the aortic arch. MRI was the preferred imaging modality for patients presenting between 4.5 and 24 hours after onset, or when posterior circulation stroke was suspected. The MRI protocol comprised axial diffusion-weighted imaging (b = 0 and 1000 s/mm^2), ADC maps, T2*-weighted gradient echo, and fluid-attenuated inversion recovery (FLAIR) sequences. Time-of-flight (TOF) MR angiography was performed without contrast from the foramen magnum to the roof of the lateral ventricles, using a 1.8 mm slice thickness, TR/TE of approximately 23/3.5 ms, and an 18° flip angle. When both CT and MRI were available, the most recent examination—typically MRI—was used for analysis.

All MT procedures were conducted in a hybrid operating room equipped with a single-plane angiographic system. Five interventional neuroradiologists, each with between 2 and 10 years of neurovascular intervention experience, performed the cases. Intravenous thrombolysis (IVT) was administered to eligible patients presenting within 4.5 hours of symptom onset, except when contraindications were present or the patient declined treatment. Patients who received IVT were transferred directly for cerebral angiography, irrespective of any observed neurological improvement. If large-vessel occlusion was confirmed, MT was undertaken using aspiration alone, a stent retriever alone, or a combination of both approaches (Figure 1).

Procedural success was defined as achieving an mTICI score of ≥2b [16]. Following successful recanalization, control angiograms were obtained after 10-15 minutes to assess for high-grade intracranial atherosclerotic disease (ICAD), which was diagnosed when either ≥70 % luminal narrowing or evidence of hemodynamic compromise within the affected vascular territory was present [17]. High-grade extracranial atherosclerotic disease (ECAD) or tandem lesions encountered during MT were classified using the North American Symptomatic Carotid Endarterectomy Trial (NASCET) definition of ≥70 % stenosis [18].

A post-procedure XperCT was obtained in all patients who had received IVT. In cases where follow-up angiography revealed re-occlusion due to high-grade ICAD, treatment consisted of intra-arterial or intravenous eptifibatide. If vessel patency could not be restored despite antiplatelet infusion, stent placement was subsequently performed (Figure 2). For high-grade ECAD, angioplasty was carried out immediately if the stenosis hindered advancement of the guiding catheter into the distal artery; when the lesion was not flow-limiting, carotid angioplasty was planned within two weeks after the thrombectomy.

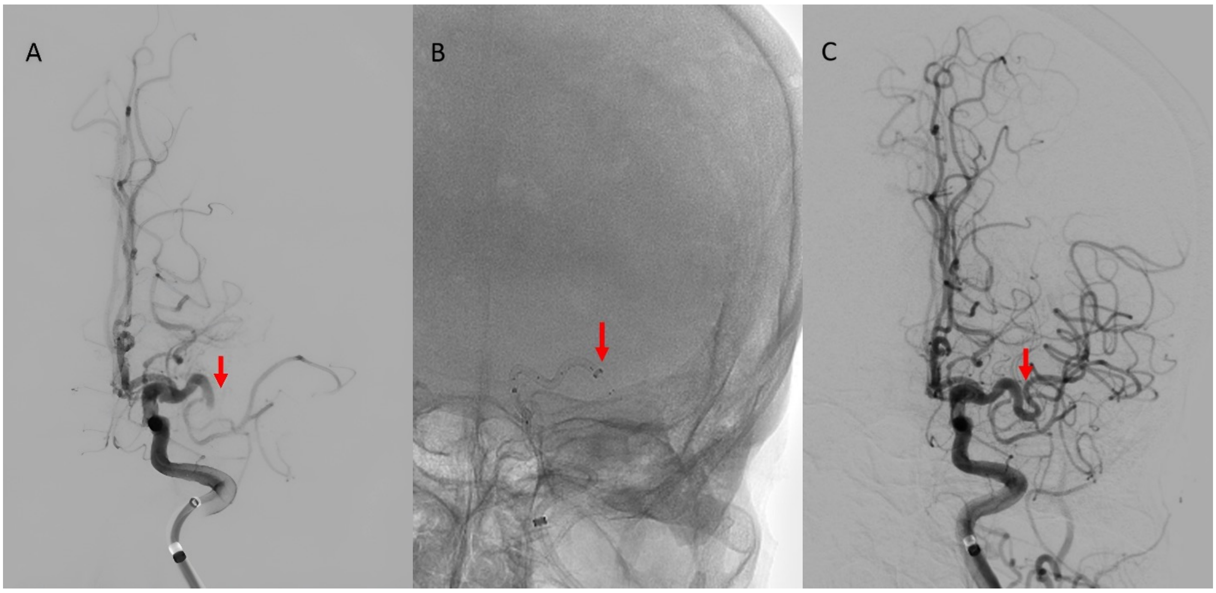

Figure 1. *MT in a 78-year-old female patient presenting with acute right hemiparesis, global aphasia and acute left MCA occlusion at the M1 segment with marked vessel tortuosity, treated using a combined aspiration and stent retriever technique. All angiograms were obtained in Towne 25° projection.*
(A) Left ICA injection demonstrating complete occlusion of the left M1 segment.
(B) Combined MT performed at the M1 segment of the left MCA.
(C) Post-procedure angiogram showing successful recanalization (mTICI 2c) of the left MCA, with persistent vessel tortuosity.
At the 3-month clinical follow-up, the patient had improved with only mild residual hemiparesis and an mRS of 2.

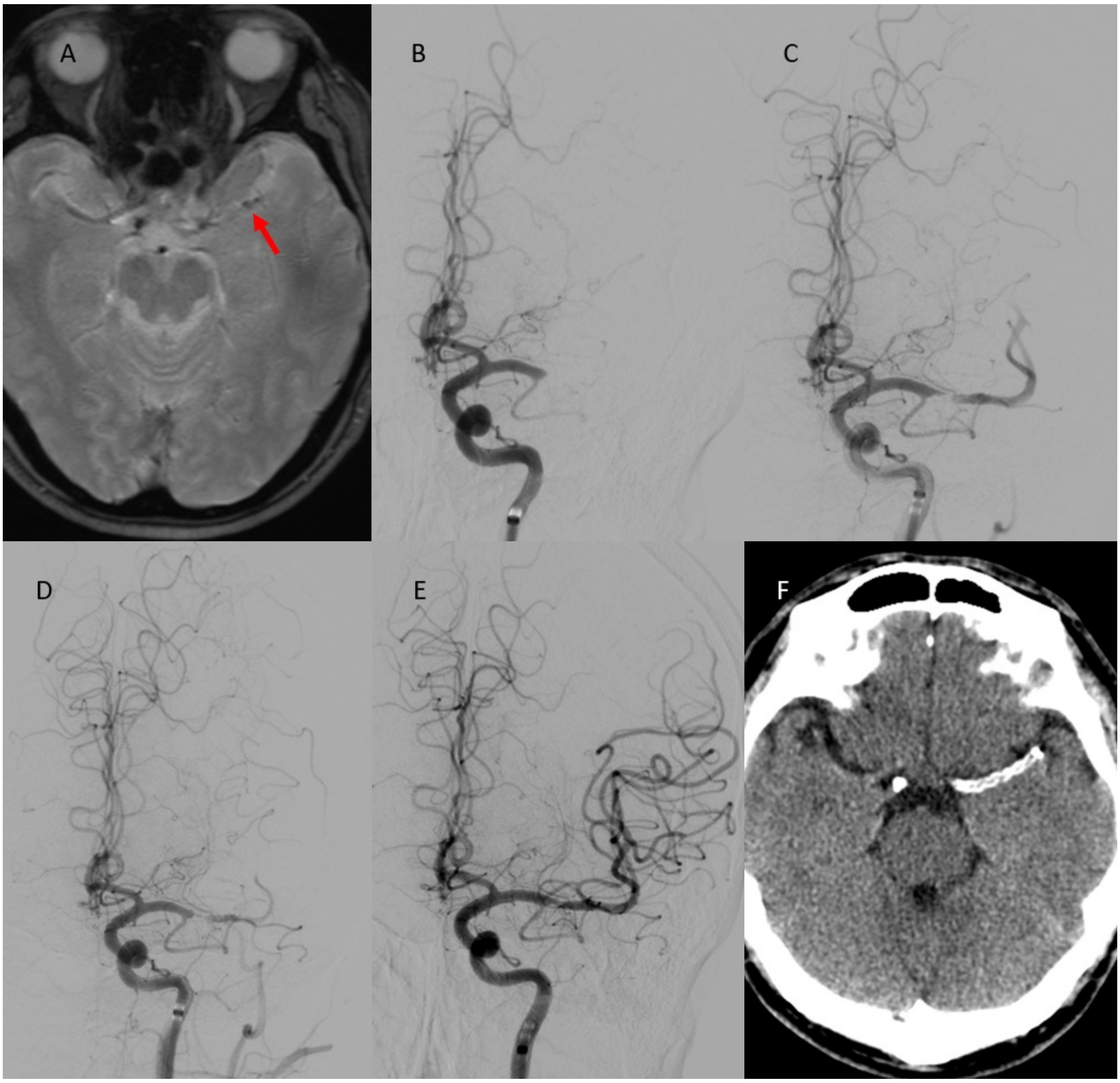

Figure 2. *MT in a 42-year-old male heavy smoker with acute left M1 MCA occlusion and high-grade ICAD, presenting with right hemiparesis and sensory aphasia, treated with a combined aspiration and stent retriever approach.*
(A) T2-GRE MRI demonstrated absence of a susceptibility vessel sign, suggesting a non-red blood cell thrombus, a finding often associated with ICAD.
(B) Left ICA injection showed complete occlusion of the left M1 segment MCA.

(C) Ten minutes after MT, angiography revealed severe residual stenosis with insufficient antegrade flow.
(D) After an IA bolus of eptifibatide was administered, persistent poor flow was still noted.
(E) Post-stent placement across the high-grade ICAD lesion, left ICA injection demonstrated complete recanalization and reperfusion (mTICI 3).
(F) 12-hour Follow-up CT scan showed no hemorrhagic transformation as well as stent placement in the left M1 segment MCA.
At the 3-month follow-up, the patient achieved complete recovery with an mRS of 0.

All patients without contraindications were started on dual antiplatelet therapy for at least three months. After MT, patients were admitted to the neuro-intensive care unit (NICU). A non-contrast CT scan was repeated between 12 and 24 hours after stroke onset. If intraparenchymal hyperattenuation was detected, another CT was performed after 24 hours to distinguish post-thrombectomy contrast staining from hemorrhage. Symptomatic intracerebral hemorrhage (sICH) was defined according to the ECASS II/III framework: radiological evidence of intracerebral bleeding after treatment accompanied by a ≥4-point deterioration on the NIH Stroke Scale, with the hemorrhage judged to be the primary cause of neurological decline [6]. Selected patients with sICH underwent decompressive craniectomy and hematoma evacuation based on the treating neurosurgeon's clinical assessment.

Baseline characteristics, imaging, angiographic findings, number of patients receiving IVT, onset to recanalization time and number of passes to achieve successful recanalization were reviewed by the interventional neuroradiologist and clinical outcomes were reviewed by two stroke neurologists. Clinical outcomes were recorded in hospital records or via phone follow-up at 3 months post-stroke onset.

The primary outcome was the rate of functional independence, defined as mRS ≤2 at 90 days. Multiple logistic regression was used to analyze factors influencing functional independence rates, with odds ratios calculated for key variables.

Descriptive statistics were applied to summarize baseline data. Continuous variables are presented as means with standard deviations (SD) or as medians with interquartile ranges (IQR), while categorical variables are expressed as counts and percentages. Stroke onset was grouped into two-time windows: <4.5 hours and 4.5-24 hours. Infarct sites were classified into anterior or posterior circulation territories. Univariate analyses were first conducted to examine relationships between patient characteristics and 90-day outcomes, where a favorable result was defined as a modified Rankin Scale (mRS) score of ≤2. Comparisons of categorical variables were made using either Pearson's chi-squared test or Fisher's exact test, and continuous variables were assessed with the Wilcoxon rank-sum test. Multivariable logistic regression was then used to determine independent predictors of good functional independence. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated to measure association strength. The regression model was adjusted for potential confounding factors, including age, sex, NIHSS at admission, and the occurrence of post-procedural intracranial hemorrhage (ICH). All statistical analyses were carried out in RStudio. This study received ethics approval from the Bangkok Pattaya Hospital Ethics Committee (approval no. 1/2023).

Results

Out of 141 MT cases, 9 were excluded due to incomplete records, leaving 132 cases for analysis. The average patient age was 64.2 years (range: 25-95 years), and all patients had a pre-stroke mRS ≤2. Most patients are Thai 116/132 cases (87.8%). Stroke onset was within 4.5 hours in 77/132 cases (58.3%) and between 4.5-24 hours in 55/132 cases (41.7%). Baseline demographics and clinical characteristics are summarized in Table 1.

Table 1. *Baseline characteristics within the thrombectomy group.*

Variable	n/N	% or value
Age(years) (n=132)		
Range	25-95	
Mean (SD)	64.2 (14.1)	
Onset time		
<4.5 hours	77.0 / 132	58.3%
4.5-24 hours	55.0 / 132	41.7%
Infarction location		
Anterior circulation	116.0 / 132	87.9%
Posterior circulation	16.0 / 132	12.1%
Anterior circulation stroke (n=116)		
ASPECTS (n=42)		
ASPECT (<6)	0.0 / 42.0	0.0%
ASPECT (>/=6)	42.0 / 42.0	100.0%
DWI volume infarction(ml) (n=74)		
Mean, (SD)	22.2, (32.1)	
Median (Q1, Q3)	12.0 (6.2, 25.0)	
Range	0.0-205.0	
Small infarction (<30 mL)	60.0 / 74.0	81.1%
Moderate infarction (31-50 mL)	9.0 / 74.0	12.2%
Large infarction (>50 mL)	5.0 / 74.0	6.8%

Variable	n/N	% or value
Posterior circulation stroke (n=16)		
ASPECTS (n=16)		
4	1.0 / 16	6.3%
5	4.0 / 16	25.0%
6	4.0 / 16	25.0%
7	2.0 / 16	12.5%
8	4.0 / 16	25.0%
10	1.0 / 16	6.3%
DWI BSS (n=16)		
1	2.0 / 16	12.5%
2	8.0 / 16	50.0%
3	6.0 / 16	37.5%
mTICI		
0, 1, 2A	25.0 / 132	18.9%
2B, 2C, 3	107.0 / 132	81.1%
Present high-grade ICAD or ECAD (n=132)		
No	79/132	59.8%
ICAD	32/132	24.2%
ECAD	12/132	9.1%
Unspecified	9/132	6.8%
Pre-stroke mRS		
0	128/132	(97.0%)
1	1/132	(0.8%)
2	3/132	(2.3%)
Post stroke mRS		
Independent (≤2)	93/132	70.5%
Dependent (>2)	39/132	29.5%

Infarction location was in the anterior circulation in 116/132 cases (87.9%) and in the posterior circulation in 16/132 cases (12.1%). For anterior circulation strokes within 4.5 hours of onset, ASPECTS was used to select candidates for MT. Among the 42 patients evaluated, all had an ASPECTS of 6 or higher. No patients presented with an ASPECTS less than 6. Thus, the proportion of patients with ASPECTS ≥6 was 100% (42/42), indicating that all included cases had relatively favorable early ischemic changes on initial imaging. Of the 74 patients with DWI data, the mean infarct volume was 22.2 mL (SD: 32.1), with a median of 12.0 mL (interquartile range [IQR]: 6.2-25.0). Infarct volumes ranged from 0.0 to 205.0 ml. Based on the DAWN trial criteria [14], patients were classified into three groups according to DWI infarct volume: small (<30 mL), moderate (31-50 mL), and large (>50 mL). The large infarction group (>50 mL) represents a large core that would have been excluded from the DAWN trial. Of these patients with available DWI data, 81.1% (60/74) had small infarctions, 12.2% (9/74) had moderate infarctions, and 6.8% (5/74) had large infarctions. In several cases (6.8%), mechanical thrombectomy was performed following early presentation with negative FLAIR imaging. Despite achieving successful reperfusion (mTICI ≥2b), all of these patients had poor clinical outcomes. Among the 16 patients with posterior circulation stroke, the distribution of posterior circulation ASPECTS (PC-ASPECTS) was as follows: a score of 4 in 1 patient (6.3%), 5 in 4 patients (25.0%), 6 in 4 patients (25.0%), 7 in 2 patients (12.5%), 8 in 4 patients (25.0%), and 10 in 1 patient (6.3%). Regarding the DWI BSS, 2 patients (12.5%) had a score of 1, 8 patients (50.0%) had a score of 2, and 6 patients (37.5%) had the maximum score of 3. Among the 132 patients, 59.8% (79/132) had no evidence of high-grade ICAD or ECAD. High-grade ICAD was observed in 24.2% (32/132), while high-grade ECAD was identified in 9.1% (12/132). In 6.8% of cases (9/132), the presence of ICAD could not be determined due to failed recanalization of the occluded vessel. Of the 132 patients, 79 (59.8%) had no evidence of high-grade ICAD or ECAD. High-grade ICAD was identified in 32 patients (24.2%), and high-grade ECAD in 12 patients (9.1%). In nine cases (6.8%), the presence of ICAD could not be assessed due to unsuccessful recanalization of the occluded vessel. Among patients with high-grade ICAD, rescue therapy with intra-arterial or intravenous eptifibatide was performed in 10 cases, while one patient underwent combined eptifibatide administration and stent placement. The remaining patient with ICAD was managed with oral dual antiplatelet therapy alone. In the high-grade ECAD group, four patients underwent angioplasty and stenting, while the remaining patients were treated with dual antiplatelet therapy alone. Successful reperfusion (mTICI 2b-3 or spontaneous recanalization) was observed in 107 cases (81.1%), as demonstrated in Figures 1 and 2. This included 103 patients who achieved mTICI 2b-3 after MT and 4 patients (3.0%) with spontaneous recanalization identified during initial angiography. The remaining 25 patients (18.9%) had poor or incomplete reperfusion (mTICI 0-2a).

At 90 days, functional independence was achieved in 70.5% of patients, with the distribution of mRS shown in Figure 3. Univariate analysis (Table 2) revealed that a lower baseline NIHSS was significantly associated with functional independence at 90 days ($p = 0.024$). Patients with moderate stroke severity (NIHSS 5-15) were more frequently found in the independent group (69.9%) compared to the dependent group (46.2%). In contrast, higher stroke severity (NIHSS ≥21) was more prevalent among patients with poor outcomes (23.1% vs. 10.8%). There were no statistically significant associations between functional independence and age ($p = 0.119$), age category (<80 vs. ≥80 years; $p = 0.766$), sex ($p = 0.091$), or presence of atrial fibrillation (AF) ($p = 0.883$). In terms of treatment approach, MT alone was performed in 63 patients (47.7%), with 42 (67.0%) achieving functional independence at 90 days. The remaining 21 (33.0%) had poor outcomes. Among the 69 patients (52.3%) treated with IVT + MT, 51 (74.0%) achieved functional independence, while 18 (26.0%) had poor outcomes. The difference between the two groups was not statistically significant ($p = 0.362$). The mean onset-to-recanalization time was 486.1 minutes (SD: 267.1), with a median of 432.5 minutes. Among patients with successful recanalization, the number of device passes required had a mean of 2.3 (SD: 1.7) and a median of 2.0. There was no significant association between the number of passes and functional independence at 90 days ($p = 0.537$). After excluding 4 cases with spontaneous recanalization following IVT, 47 out of 128 patients (36.7%) achieved successful recanalization on the first pass. However, first-pass success did not result in a statistically significant difference in clinical outcomes compared to multiple-pass recanalization. Post-procedural hemorrhage occurred in 33.3% of patients (44/132) and was significantly associated with worse functional outcomes at 90 days (p = 0.001). Among patients who remained functionally independent, 75.3% had no hemorrhagic complications, compared to only 46.2% in the dependent group. Further classification revealed that sICH occurred in 9.8% of the total study, with a markedly higher rate in the dependent group (25.6%) than in the independent group (3.2%). Asymptomatic ICH (aICH) was observed in 23.5% of patients and showed less variation between outcome groups (28.2% vs. 21.5%). The association between sICH and unfavorable outcomes was statistically significant (p < 0.001), while aICH did not demonstrate a clear correlation. In cases of sICH, 4 of 13 patients (30.8%) underwent decompressive craniectomy with hematoma evacuation. Among these, two patients remained functionally dependent (mRS >2) and two died, indicating a poor overall prognosis in this subgroup.

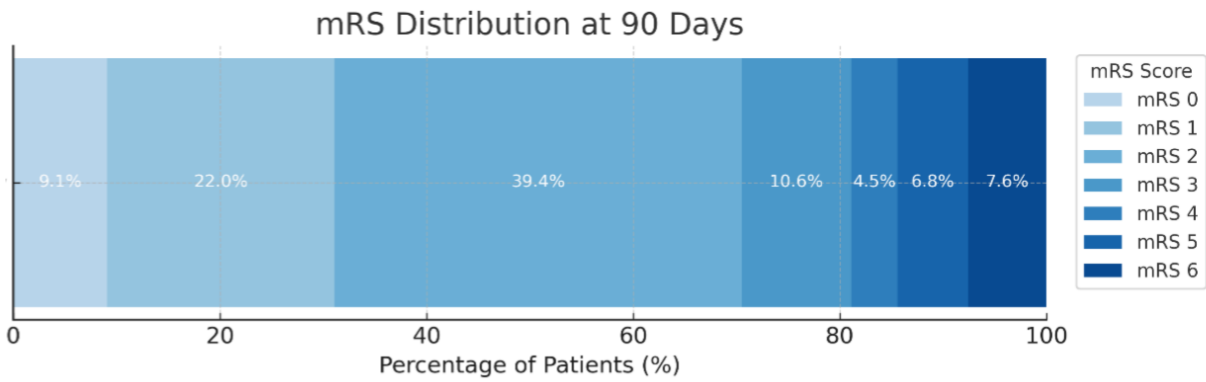

Figure 3. *Clinical outcome post-MT.*

Table 2. *Predictors of outcome data (n=132).*

Variable	Overall	Outcome (mRS 90)		p-value
		Independent (≤2), N = 93	Dependent (>2), N = 39	
Age (N = 132)				0.119[1]
Mean (SD)	64.2(14.1)	63.3(13.7)	66.3(15.1)	
Range	25.0, 95.0	30.0, 95.0	25.0, 86.0	
Age category, n / N (%)				0.672[2]
<80	111/132 (84.1%)	79/93 (84.9%)	32/39 (82.1%)	
>/=80	21/132 (15.9%)	14/93 (15.1%)	7/39 (17.9%)	
Sex, n / N (%)				0.091[2]
Male	79/132 (59.8%)	60/93 (64.5%)	19/39 (48.7%)	
Female	53/132 (40.2%)	33/93 (35.5%)	20/39 (51.3%)	
Risk factors: AF, n / N (%)	35/132 (26.5%)	25/93 (26.9%)	10/39 (25.6%)	0.883[2]
NIHSS (admission)				0.024[3]
Mild (1-4)	1/132 (0.8%)	0/93 (0.0%)	1/39 (2.6%)	
Moderate (5-15)	83/132 (62.9%)	65/93 (69.9%)	18/39 (46.2%)	
Moderate to severe (16-20)	29/132 (22.0%)	18/93 (19.4%)	11/39 (28.2%)	
Severe (21-42)	19/132 (14.4%)	10/93 (10.8%)	9/39 (23.1%)	
Treatment, n / N (%)				0.362[2]
MT alone	63/132 (47.7%)	42 / 63 (67%)	21 / 63 (33%)	
IVT+MT	69/132 (52.3%)	51 / 69 (74%)	18 / 69 (26%)	
Onset to recanalization (min.)				0.409[1]
Mean,(SD)	486.1,(267.1)	475.3,(262.2)	514.8,(281.8)	
Median (Q1, Q3)	432.5 (316.5, 551.0)	412.5 (312.0, 530.0)	442.5 (337.0, 555.0)	
Min, Max	155.0, 1,647.0	155.0, 1,647.0	165.0, 1,420.0	

Variable	Overall	Outcome (mRS 90)		p-value
		Independent (≤2), N = 93	Dependent (>2), N = 39	
Number of passes				0.537[1]
Mean, (SD)	2.3,(1.7)	2.2,(1.5)	2.7,(2.1)	
Median (Q1, Q3)	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	2.0 (1.0, 4.0)	
Min, Max	0.0, 6.0	0.0, 6.0	0.0, 6.0	
Number of passes, n / N (%)				0.985[2]
1	47 / 128 (37%)	33 / 90 (37%)	14 / 38 (37%)	
>1 or Fail	81 / 128 (63%)	57 / 90 (63%)	24 / 38 (63%)	
Post-procedure hemorrhage				0.001[2]
No	88/132 (66.7%)	70/93 (75.3%)	18/39 (46.2%)	
Yes	44/132 (33.3%)	23/93 (24.7%)	21/39 (53.8%)	
Post-procedure hemorrhage				<0.001[2]
No	88/132 (66.7%)	70/93 (75.3%)	18/39 (46.2%)	
Symptomatic ICH	13/132 (9.8%)	3/93 (3.2%)	10/39 (25.6%)	
Asymptomatic ICH	31/132 (23.5%)	20/93 (21.5%)	11/39 (28.2%)	

[1] *Wilcoxon rank sum test*
[2] *Pearson's chi-squared test*
[3] *Fisher's exact test*

In the multivariate logistic regression analysis (Table 3), both post-procedural aICH and the absence of any hemorrhage were independently associated with a lower likelihood of achieving functional independence at 90 days. Specifically, aICH was linked to decreased odds of functional independence (OR 0.09; 95% CI, 0.02-0.45; $p = 0.006$), and the absence of ICH showed an even stronger inverse association (OR 0.05; 95% CI, 0.01-0.20; $p < 0.001$), when compared to sICH as the reference group. Although lower baseline NIHSS was significant in the univariate analysis ($p = 0.024$), it only showed a borderline association in the multivariable model ($p = 0.059$). Patients with moderate stroke severity on admission (NIHSS 5-15) demonstrated a trend toward better functional outcomes compared to those with severe scores (NIHSS >20), although this did not reach statistical significance (OR 0.31; 95% CI, 0.09-1.06; $p = 0.059$). Age, sex, and presence of AF were not significantly associated with clinical outcome in the adjusted model.

Table 3. *Multivariable logistic regression between patient factors and outcome (mRS 90 days) (n=131*).*

Variable	Event N[1]	OR (95% CI)[2]	p-value
Age	69.5 (62.3, 77.0)	1.02 (0.99 to 1.06)	0.167
NIHSS (admission)			
Severe (21-42)	9/19 (47.4%)	Reference	
Moderate to Severe (16-20)	11/29 (37.9%)	0.70 (0.18 to 2.76)	
Moderate (5-15)	18/83 (21.7%)	0.31 (0.09 to 1.06)	0.059
Post-procedure hemorrhage			
Symptomatic ICH	10/13 (76.9%)	Reference	
Asymptomatic ICH	11/31 (35.5%)	0.09 (0.02 to 0.45)	0.006
No	17/87 (19.5%)	0.05 (0.01 to 0.20)	<0.001

[1]Event N = the number of patients who had an mRS >2
[2]OR = odds ratio, CI = confidence interval
Adjusted by age, gender, post-procedure hemorrhage
** Excluding a case with mild NIHSS (< 5)*

The relationship between treatment modality and post-procedural hemorrhage, including symptomatic ICH, is summarized in Table 4. The incidence of post-procedural hemorrhage significantly differed between treatment groups (p = 0.027). Patients who received IVT+ MT had a higher rate of post-procedural hemorrhage (42.0%) compared to those treated with MT alone (23.8%). When classified further, sICH occurred in 17.4% of the IVT+MT group, significantly higher than in the MT-alone group (1.6%) (p = 0.006). The rate of aICH was similar between the two groups: 22.2% in the MT-alone group and 24.6% in the IVT+MT group. Patients who underwent thrombectomy without preceding IV thrombolysis were more likely to remain free of any hemorrhagic complication (76.2% vs. 58.0%).

Table 4. *Association between treatment modality and post-procedural hemorrhage and aymptomatic ICH.*

Variable	Overall N = 132[1]	Group		p-value
		MT alone N = 63[1]	IVT+MT N = 69[1]	
Post-procedure hemorrhage	44/132 (33.3%)	15/63 (23.8%)	29/69 (42.0%)	0.027[2]
Post-procedure hemorrhage				0.006[2]
No	88/132 (66.7%)	48/63 (76.2%)	40/69 (58.0%)	
Asymptomatic ICH	31/132 (23.5%)	14/63 (22.2%)	17/69 (24.6%)	
Symptomatic ICH	13/132 (9.8%)	1/63 (1.6%)	12/69 (17.4%)	

[1] *n/N (%)*
[2] *Pearson's chi-squared test*

Discussion

This study evaluates the clinical outcomes of MT, focusing on the 90-day functional independence rate and factors influencing success. Our findings demonstrate a high rate of procedural success (81%) and functional independence (70.5%) post-MT, which are consistent with outcomes reported in global MT registries and randomized clinical trials [10, 14, 19-20].

Imaging Selection and Procedural Success Rate

Patients presenting within 4.5 hours were selected based on ASPECTS, and nearly all (98%) had scores indicating small-to-moderate infarction cores, reflecting adherence to standard guidelines [9]. For the 4.5-24-hour window, DWI was a main tool for precise patient selection, with the majority demonstrating small core infarctions and clinical imaging mismatch [14]. This emphasizes the critical role of advanced imaging in extending treatment eligibility while maintaining functional independence (70.5%).

The high successful recanalization rate (81%) was consistent with outcomes reported in major randomized trials [10, 19-20]. Patients who received IVT were transferred directly for cerebral angiography, enabling prompt assessment and rapid initiation of MT if LVO persisted. This streamlined workflow allowed for vessel status confirmation within 30 minutes and revealed spontaneous recanalization in 4 of 132 patients (3%).

This finding aligns with results from the EXTEND-IA trial, which reported early recanalization in approximately 10% of patients receiving IVT before MT [20]. Although our observed rate was slightly lower, both findings underscore the potential for IVT to achieve timely reperfusion in a subset of patients, highlighting the importance of immediate post-IVT angiographic assessment to avoid unnecessary intervention and minimize procedural risks.

Clinical Outcomes and Predictors

Our analysis did not find a significant association between onset-to-recanalization time and 90-day functional independence (p = 0.409). Although patients who achieved functional independence had a slightly shorter mean time to recanalization (475.3 minutes) compared to those with poor outcomes (514.8 minutes), this difference was not statistically significant and did not appear to impact outcomes in a clinically meaningful way. This contrasts with prior meta-analyses and multicenter trials that have highlighted time to reperfusion as a key determinant of outcome. For example, the HERMES collaboration found that shorter time from symptom onset to reperfusion was strongly associated with higher odds of functional independence, particularly when treated within the early window of under 6 hours [10]. Similarly, analyses from the DAWN and DEFUSE-3 trials emphasized that even in extended time windows, timely intervention in well-selected patients still conferred benefit [14, 19]. There are several possible reasons for the divergence from previous findings. First, the average time to recanalization in our study was considerably longer than in earlier trials, with broad variability (ranging from 155 to 1,647 minutes), potentially obscuring any true time-dependent effect. Second, other factors—such as infarct core volume, collateral status, presence of hemorrhagic complications, or procedural details—may have played a more substantial role in determining outcome. Lastly, unlike many prior studies that used strict imaging selection criteria, our study included a more heterogeneous population, reflective of real-world clinical practice. These findings suggest that while time remains a critical factor in stroke intervention, its predictive power may diminish when other variables are more influential.

Achieving first-pass success did not correlate with better functional independence at 90 days. Both the independent and dependent outcome groups demonstrated a 37% rate of first-pass success, with a similar distribution between single and multiple retrieval attempts. No significant statistical difference was observed (p = 0.985). These results imply that, within our study, procedural efficiency alone may not necessarily lead to improved clinical outcomes. This contrasts with several previous meta-analyses and observational studies, which have consistently found a positive relationship between first-pass effect (FPE) and functional independence.

For instance, Abbasi et al. reported that roughly one-third of patients experience FPE, and this was linked with better outcomes across thrombectomy techniques [21]. Several factors may account for the discrepancy between our findings and prior literature. Firstly, while our first-pass rate aligns with pooled data from other studies, the sample size may not have been large enough to detect a modest effect. Secondly, clinical outcomes may have been more heavily influenced by other variables, such as infarct size, collateral status, or the presence of complications like sICH. Lastly, technical aspects including device selection, operator technique, or patient characteristics could have altered the impact of FPE. Despite the absence of a significant association in our study, previous meta-analyses, including that of Jang et al., have consistently reported that achieving FPE is linked to higher rates of favorable neurologic recovery, shorter procedural duration, and lower complication rates, including vessel injury, distal embolization, and mortality [22].

The 90-day functional independence rate (70.5%) aligns with benchmarks reported in major trials [10]. Post-procedural aICH or absence of ICH significantly reduced the dependence rate, consistent to Pinckaers, et al [23]. According to the Koopmans, et al [24]. who proposed that large ischemic core volume is associated with poor outcome and post-MT ICH, careful imaging selection of MT candidates is very important. Age was not a significant factor compared to Winkelmeier, et al. [25], this divergence could be attributed to the relatively small sample size or the specific characteristics of the population treated at our center. The other factors, including sex and AF also did not significantly impact clinical outcomes, consistent with several studies [26-28]. Interestingly, admission NIHSS demonstrated a borderline significant association with outcomes ($p=0.059$), suggesting that moderate strokes tended to have better clinical outcomes than severe strokes. We hypothesize that moderate stroke patients recover faster than severe stroke patients.

In our retrospective analysis, functional independence was achieved at 90 days in 67.0% of patients treated with MT alone and 74.0% of those receiving IVT + MT, with no statistically significant difference between the two groups ($p = 0.362$). This is consistent with the results of the DIRECT-MT and DEVT trials, which found that direct thrombectomy was not inferior to bridging therapy with IVT

+ MT in terms of functional independence at 90 days [29,30]. However, our data also showed a higher rate of symptomatic intracranial hemorrhage in the IVT + MT group compared to MT alone (17.4% vs. 1.6%; p = 0.006), a finding that warrants careful consideration in light of the balance between potential benefits and hemorrhagic risks. The significantly higher rate of symptomatic intracerebral hemorrhage (sICH) in the IVT + MT group may reflect several procedural and patient-specific factors. A recent systematic review identified the number of thrombectomy passes, age, serum glucose, AF and NIHSS score as predictors of any intracranial hemorrhage following reperfusion therapy [31].

Procedural Variables and Treatment Strategies

Approximately half of the patients received combined MT and IVT, reflecting real-world variability in treatment approaches. While our study did not directly compare outcomes between MT alone and MT with IVT, the high recanalization and functional independence rates suggest that both strategies are effective when guided by appropriate imaging.

Additionally, the incidence of high-grade ICAD in 24.2% of cases highlights its significant prevalence in the Thai population (87.8%) which is relatively high in Asia people with sICH [32]. These patients were mainly rescued by stent retrieval MT, combined MT or adjunctive IA/IV eptifibatide.

Limitations and Future Directions

This study has several limitations. Its retrospective, single-center design may limit the generalizability of the findings, and incomplete data from nine cases highlights the need for more comprehensive data collection in future work. Previous research has shown that well-controlled blood pressure is associated with improved outcomes after ischemic stroke [33] and that the absence of diabetes mellitus or optimal glycemic control is linked to better prognosis [34]. As our study did not collect information on these variables, their potential impact on clinical outcomes could not be evaluated. Prospective, multicenter studies with larger sample sizes are warranted to confirm these results and to further investigate the role of other factors, such as ICAD, ECAD, or population-specific characteristics, in influencing MT outcomes.

Conclusion

MT at our single-center stroke unit in Thailand achieved outcomes comparable to international benchmarks, with 81% successful reperfusion and 70.5% functional independence at 90 days. Imaging-based selection with ASPECTS and DWI likely contributed to these results. Post-procedural aICH or the absence of any hemorrhage was independently associated with a lower likelihood of achieving functional independence compared with sICH, highlighting the complex interplay between hemorrhagic patterns and recovery. Predictive factors such as age, sex, and AF were not independently associated with outcome, though admission NIHSS showed borderline significance, suggesting that moderate deficits may offer greater recovery potential. Time to reperfusion and FPE were not significant predictors in this study, indicating that other clinical and procedural variables may outweigh timing in certain real-world settings. The higher hemorrhage risk observed with bridging therapy underscores the importance of careful patient selection when considering IVT before MT.

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Original Article

Infection prevention and control practices in the radiology department: An Asia-Oceania survey

Norlisah Mohd Ramli, MBBS, FRCR[1,2]
Wiwatana Tanomkiat, M.D.[3]
Evelyn Lai Ming Ho, MBBS, MMed[4]
Noriyuki Tomiyama, M.D., Ph.D.[5]
From [1]Department of Radiology, Subang Jaya Medical Centre, Selangor, Malaysia,
[2]Department of Biomedical Imaging, University of Malaya, Kuala Lumpur, Malaysia,
[3]Department of Radiology, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkla, Thailand,
[4]Imaging Department, ParkCity Medical Centre, Kuala Lumpur, Malaysia,
[5]Diagnostic and Interventional Radiology, Graduate School of Medicine, Osaka University, Osaka, Japan.
Address correspondence to N.R. (e-mail: norlisahramli@gmail.com)

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Abstract

Objective: To evaluate the current infection prevention and control (IPC) practices in radiology departments (RDs) across the Asia-Oceania region (AOR) and identify strengths and areas for improvement to promote the development of standardized IPC guidelines tailored to diverse local contexts.

Materials and Methods: In November 2023, the Asian Oceanian Society of Radiology (AOSR) Quality, Safety, and Standards Committee distributed a structured survey to radiology professionals across 22 countries, special administrative regions (SAR), and territories. The survey assessed five key areas: demographics, policy implementation, room assessment, departmental IPC practices, and recent measures. Descriptive statistics were used to analyze the responses. Ethical approval was obtained, and participation was voluntary.

Results: We received 122 survey responses from 22 countries, regions, and territories. While 74.6% (88/118) of the countries had national IPC programs, only 68.9% (84/122) of RDs had department-specific IPC policies, with 50.8% (62/122) adhering to WHO guidelines. 96.7% (118/122) of RDs reported adequate hand hygiene facilities, and 82.0% (100/122) had sufficient personal protective equipment. However, practices such as patient screening and disinfection after use were inconsistent. The COVID-19 pandemic prompted 85.2% (104/122) of RDs to enhance infection prevention and control (IPC) measures, including audits and the implementation of new isolation protocols. Staff training and IPC adherence varied widely, with only 62.3% (76/122) of RDs reporting consistent adherence to IPC.

Conclusion: The survey highlights that, despite significant progress in IPC practices across RDs in the AOR, gaps in policy standardization, staff training, and resource allocation persist. Enhancing education, promoting a no-blame culture, and aligning departmental policies with international guidelines are essential for improving patient safety and reducing healthcare-associated infections. Tailored AOSR guidelines could address regional disparities and foster consistent IPC implementation.

Keywords: Asia-Oceania, Infection Prevention and Control (IPC), Radiology safety, Radiology departments, Healthcare-Associated Infections (HAIs), Survey, Quality Improvement, COVID-19 Impact.

Introduction

Radiology safety includes radiation protection, magnetic resonance hazards, contrast agent-related risks, and infection prevention and control (IPC). While radiation protection, magnetic resonance safety, and contrast agent management have received significant attention, IPC in radiology is often overlooked despite its critical importance in patient safety. [1]. Over the past three decades, the risk of healthcare-associated infections (HAIs) has risen in radiology departments (RDs), partly due to increased patient volume and the widespread use of imaging modalities [2].

Recently, the World Health Organization (WHO) has recommended the use of chest X-rays for screening for pulmonary tuberculosis [3] and for initial imaging during the COVID-19 pandemic [4]. This highlights the growing need for radiology professionals to be knowledgeable about IPC practices, particularly in high-risk environments such as radiology departments (RDs).

HAIs lead to substantial economic burdens and pose significant challenges to clinical outcomes and healthcare costs [5]. Effective IPC prevents avoidable HAIs and ensures safe, high-quality healthcare [6]. The WHO guidelines for IPC, issued in 2016, provide a framework for implementing effective IPC practices at national and facility levels [7]. However, the feasibility of applying these guidelines universally varies according to local context, and adaptation is often necessary due to specific regional and institutional challenges.

In low-resource settings, hospitals face challenges such as inadequate IPC governance, insufficient funding, understaffing, and a lack of essential resources, including sanitation facilities [8, 9]. Many hospitals also struggle with poor infrastructure, including inadequate water, sanitation, and hygiene systems [10], and often lack comprehensive infection surveillance mechanisms [11]. Additionally, overcrowding and insufficient staff training compromise the effectiveness of IPC measures [12].

While intensive care units receive much of the focus regarding HAIs, RDs also play a critical role in patient management, and both patients and healthcare workers in these departments can be at risk for acquiring HAIs [13]. Furthermore, recent outbreaks have shown that HAIs can occur not only in inpatient settings but also in outpatient settings, underlining the importance of addressing IPC in all healthcare environments [14].

A worldwide WHO IPC survey was conducted in 2019, examining health facilities in general, but not RD specifically [15]. Recognizing the growing need for standardized IPC practices in radiology, the Asian Oceanian Society of Radiology (AOSR) Quality, Safety, and Standards (QSS) Committee initiated a survey to evaluate current IPC policies and practices across RDs in the AOR. This study aims to identify strengths and areas for improvement in IPC practices within the region, with the intention of promoting the development of an AOSR IPC policy tailored to diverse local contexts. This study aims to contribute to ongoing efforts to enhance IPC measures in radiology, ultimately improving patient outcomes and healthcare quality throughout the region by analyzing the findings.

Materials and methods

Survey Design and Distribution

The AOSR QSS Committee developed a structured survey to assess IPC practices in RDs across the AOR. The survey was designed with radiology and infection control experts to ensure comprehensive coverage of relevant topics. At the same time, to ensure maximum participation, the survey was intended to be brief enough to be completed within 5 minutes. The survey focused on five key areas:

1. **Demographics:** Information about the respondents, including their role, institution, and country/region, was collected,
2. **Policy:** The existence and scope of IPC policies at national, institutional, and departmental levels were evaluated,
3. **Room Assessment:** The physical infrastructure and resources available for IPC in RDs were assessed,

4. **IPC Policy in the RD:** Data on the implementation and adherence to IPC policies within the departments were gathered,
5. **Ongoing Measures:** Recent actions or changes to enhance IPC practices, particularly in response to the COVID-19 pandemic [4] were documented.

The survey questionnaire is provided in the Supplement. To ensure broad accessibility, the survey was translated from English into several languages, including Russian and Japanese. It was distributed to RDs via email and professional networks in November 2023, with responses collected in December 2023.

To maximise accessibility and response, an introduction to the survey included a statement assuring participants that "no particular person, institution or country/region/territory will be named in the survey report" and that "your answers will remain private and confidential." Completion of the survey was taken as implied consent. While respondents had the option to provide their name and email address (e.g., for follow-up communication or clarification), these details were not linked to the survey responses during analysis or reporting, and all data were treated as anonymous.

The AOSR QSS Committee ensured that the results would be used solely to improve IPC practices in RDs. The online survey was approved for Exemption Determination (according to SOP version 3, Chapter 5) by the Human Research Committee of the Faculty of Medicine, Prince of Songkla University (REC.68-078-7-1).

Respondents
The survey targeted radiologists, department managers, IPC officers, and other relevant personnel working in RDs across the Asia-Oceania region (AOR). Participation was voluntary and at their convenience.

Data Collection and Analysis

The responses were compiled into a central database for analysis. The responses were then anonymized by removing the names and analyzed using descriptive statistics to summarize the key findings. The study focused on identifying standard practices, gaps in policy implementation, and variations across different countries and institutions. The descriptive statistical methods included frequency distributions and percentages.

Results

Response Rate and Demographics

The survey received 122 individual responses from 108 RDs across 22 countries, special administrative regions (SAR), and territories in the AOR. Most respondents were heads or directors of RDs 47.5% (58/122), followed by radiologists 43.4% (53/122). The respondents were primarily from hospitals, 70.5% (86/122), and centers 28.6% (35/122), with a smaller proportion from standalone radiology clinics 0.9% (1/122). The geographic distribution of responses was diverse, with notable representation from countries such as Japan, Thailand, and Malaysia, each offering a variety of healthcare settings (Figure 1).

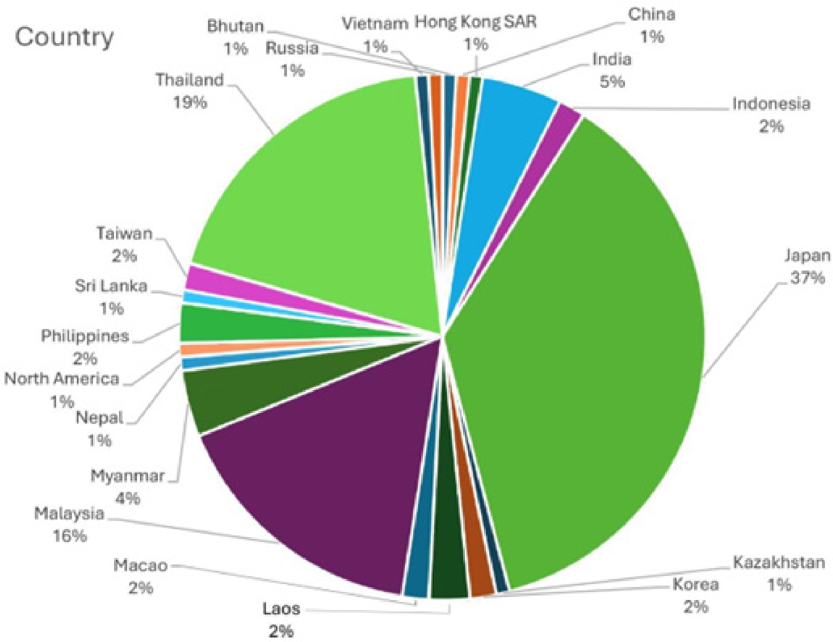


Figure 1. *Percentage distribution of respondents (i.e., RDs) for the IPC survey, categorized by country, SAR, and territory; data are presented as percentages of the total of 122.*

IPC Policy Implementation

The survey revealed that 74.6% (91/122) of the respondents reported being aware of having an IPC committee or program at the national level in their respective countries. These respondents cover all 22 AOR. The countries with 4.9% (6/122) respondents, who were not aware of having a national IPC came from Malaysia, Thailand, and Japan. Therefore, across countries, awareness may vary. At the hospital or center level, the awareness of IPC policy was high, with 92.6 % (113/122) of the respondents indicating knowledge of IPC procedures. However, only 68.9% (84/122) of the respondents reported having a formal IPC policy for their RDs (Figure 2). Among those with an IPC policy, 51.2% (43/84) adhered to the WHO's Guidelines on Core Components of IPC Programmes. In contrast, others either followed local guidelines or did not have a specific IPC policy in place.

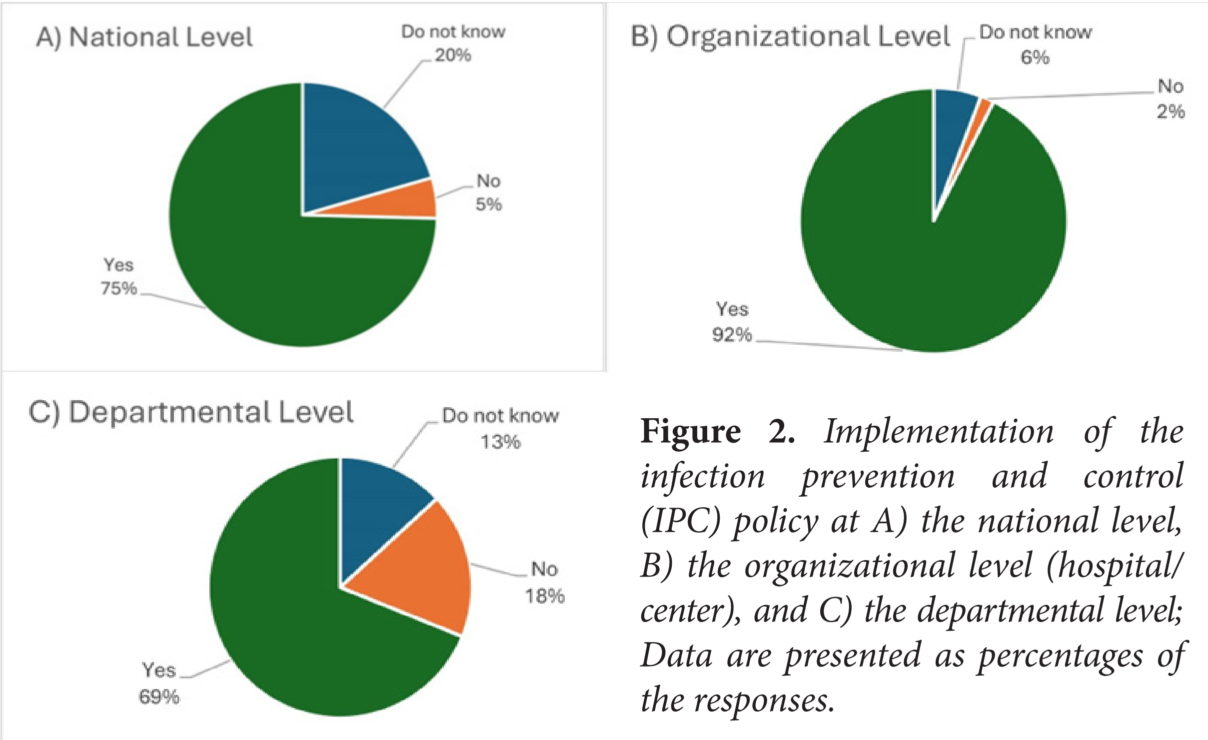
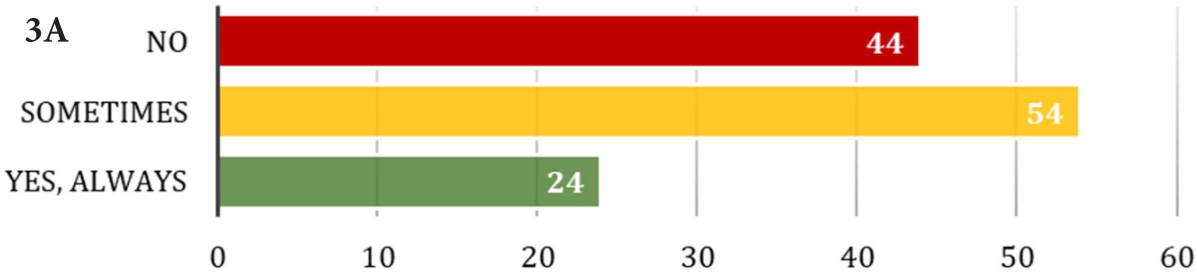


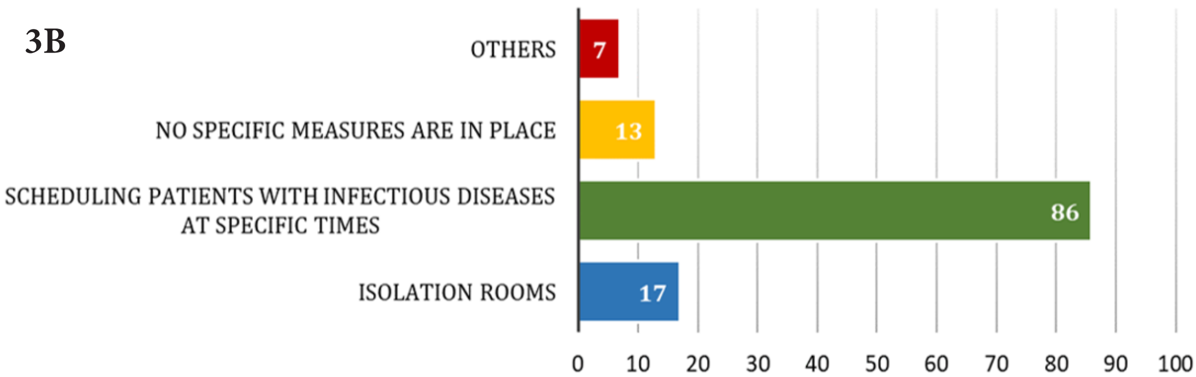
Figure 2. *Implementation of the infection prevention and control (IPC) policy at A) the national level, B) the organizational level (hospital/ center), and C) the departmental level; Data are presented as percentages of the responses.*

Room Assessment and Resources

Regarding infection screening practices, only 19.7% (24/122) of the respondents reported that visitors were screened for infectious diseases before entering, 44.3% (54/122) indicated that this screening occurred only occasionally, and 36.0 % (44/122) reported no screening (Figure 3A). For managing patients with infectious diseases, 70.5% (86/123) of the respondents scheduled these patients at specific times, 13.9% (17/123) used isolation rooms, and 10.7% (13/123) had no specific measures in place. Approximately 5.7% (7/123) employed additional measures, such as wrapping the probe with cling film and performing room clean-up afterwards, while one respondent chose both isolation and scheduling (Figure 3 B).



	YES, ALWAYS	SOMETIMES	NO
Q1	19.7%	44.3%	36.0%

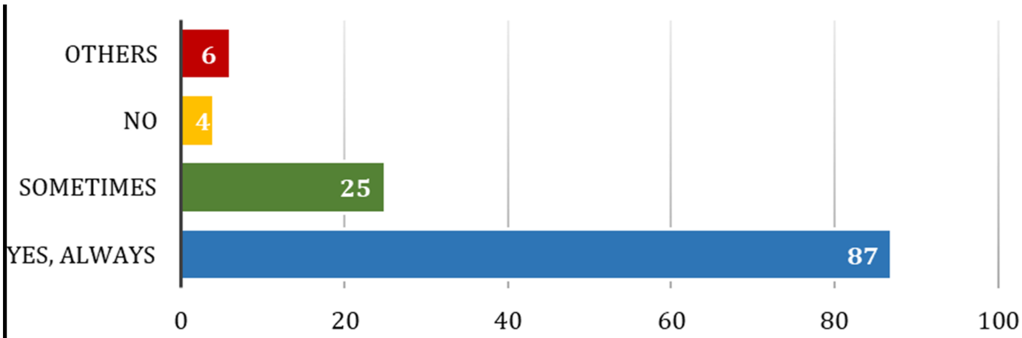


	ISOLATION ROOMS	SCHEDULING PATIENTS WITH INFECTIOUS DISEASES AT SPECIFIC TIMES	NO SPECIFIC MEASURES ARE IN PLACE	OTHERS
Q2	13.9%	70.5%	10.7%	5.7%

NOTES:
OTHERS:
1. Basic measures like masking, hygiene & premise cleaning
2. Have work instruction/ guideline for infectious patient
3. If infection means fever, they are identified by measuring body temp and questions.
4. Practice 5 moments of hand hygiene, wrapping up the US probe with cling wrap, discard the linen after infectious cases.
5. It was screen from the entrance of the hospital
6. Perform room cleanup after infectious disease patient scan
7. The entire hospital is doing this.

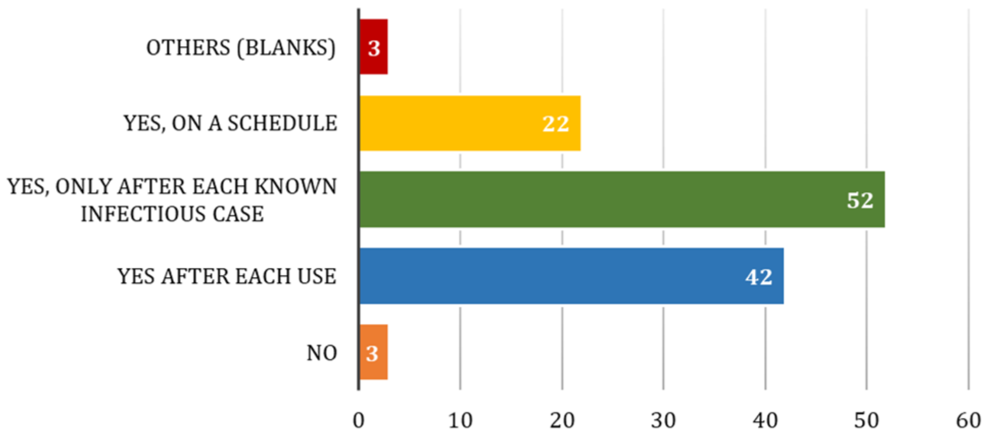
Figure 3. *A) Infection screening practices before entering RDs and B) Management of infectious patients in RDs.*

When assessing IPC infrastructure, 87.7% (107/122) of the respondents reported that hand hygiene guidelines were displayed in the room, while 12.3% (15/122) observed the absence of such guidelines. 96.7% (118/122) of the respondents confirmed the availability of adequate sinks, soap, and hand-rub dispensers in their RDs. Personal protective equipment was reported as sufficiently available by 82.0% (100/122) of the respondents. Additionally, 71.3% (87/122) reported cleaning rooms or equipment after each use. In comparison, 20.5% (25/122) did so only sometimes (Fig. 4A). Regarding disinfection practices, 42.6% (52/122) indicated that rooms or equipment were disinfected only after known infectious cases, 34.4% (42/122) reported disinfection after each use, and 18% (22/122) conducted disinfection on a scheduled basis (Fig. 4B). Furthermore, 83.6% (102/122) confirmed that sharps disposal bins were available throughout the RDs. However, 13.9% (17/122) indicated these were available only in certain procedures or imaging rooms.



	YES, ALWAYS	SOMETIMES	NO	OTHERS
Q6	71.3%	20.5%	3.3%	4.9%

NOTES:
OTHERS:
1. After the infectious case.
2. Clean everyday or after infected case.
3. Equipment are cleaned after each use; however regular room cleaning is done on daily basis.
4. Not after each patient.
5. Not each use but infectious cases only.
6. Unless it was soiled, or dirtied in some manner - spills etc.



	NO	YES AFTER EACH USE	YES, ONLY AFTER EACH KNOWN INFECTIOUS CASE	YES, ON A SCHEDULE	OTHERS (BLANKS)
Q7	2.5%	34.4%	42.6%	18.0%	2.5%

Figure 4. *RDs room or equipment practices on A) cleaning and B) disinfection.*

IPC Policy in the Radiology Department

The majority of respondents, 62.3% (76/122), indicated that their RDs consistently followed IPC policies, while 36.9% (45/122) reported receiving limited or no IPC training for staff. Incident reporting was encouraged in 52.5% (64/122) of RDs, and a no-blame culture was in place. 59.0% (72/122) of respondents noted that staff were encouraged to report IPC breaches. Management support for IPC implementation and enforcement was reported as "very supportive" by 41.0% (50/122) of the respondents, "somewhat supportive" by 21.3% (26/122), and "not supportive at all" by 0.8% (1/122). IPC audits were conducted monthly in 14.8% of RDs, quarterly in 19.7%, and annually in 15.6% of RDs. Only 32.8% (40/122) of the respondents had received feedback on their adherence to IPC policies in their RDs.

Recent Measures and Improvements

In response to the COVID-19 pandemic, 85.2% (104/122) of RDs implemented new measures to enhance IPC practices. Of the total respondents, 24.6% (30/122) reported recent infectious disease events in their RDs, while 63.9% (78/122) reported no such cases. To improve IPC, many RDs introduced audits, multidisciplinary team meetings, and the installation of negative pressure suites for interventional procedures. Key improvements indicated by the respondents were increased staff education, enhanced hand hygiene protocols, more stringent isolation measures, and improved use of protective equipment. Several departments adhered to existing hospital IPC policies and adopted additional practices, such as environmental disinfection and air purification. Some RDs sought external guidance and maintained patient communication through various channels.

RDs implemented waste segregation to enhance infection control, conducted regular screenings, and updated IPC policies according to hospital guidelines. Specific measures for interventional procedures included infection screening, mandatory mask-wearing, thorough hand hygiene, and dedicated examination rooms for infectious patients. Monthly guidance from the IPC Committee and hospital rounds were conducted, and the IPC manual was revised biannually. Regular audits, standards of operations, and rapid response protocols were established, particularly in response to the COVID-19 pandemic, which included hand hygiene campaigns and workflow reviews.

Furthermore, 62.3% (76/122) of the respondents agreed that AOSR policy or guidelines, based on fundamental principles tailored to local contexts, would benefit both institutions and the wider society. These standard, evidence-based international and national guidelines are crucial for effective IPC in RDs, as clinical environments are high-risk areas. Continuous education and dissemination of knowledge to all staff members were seen as essential. While a nurse in the department was responsible for IPC and participated in the hospital's IPC committee, the specific guidelines were not always clear, and variations in practices were noted across different hospital chains. Concerns about doctors' inconsistent use of infection control measures and some vague responses to survey questions also emerged.

Discussion

IPC has long played a critical role in reducing the burden of HAIs and combating antimicrobial resistance, with its foundational principles dating back to 1998 in the USA. Since then, IPC strategies have been widely implemented at acute healthcare facility levels across the globe, supported by the WHO through core IPC program guidelines in 2009. These guidelines aim to provide evidence-based support for IPC at both national and healthcare facility levels, and they are tailored to meet the needs of both high- and low-resource settings [16, 17]. Implementing IPC is generally shared by all healthcare workers, not solely by IPC teams or policymakers, as the success of IPC programs depends on the awareness and adherence of all hospital staff to IPC practices.

According to a 2015 WHO survey, national IPC programs were implemented in only 41% of the member countries, with some regional variations. For instance, Europe and Southeast Asia had slightly higher coverage, and only 29% of the tertiary hospitals had formal IPC policies. [18]. However, a subsequent survey in 2024 displayed a higher level of implementation of the IPC program, reaching 72.9% having trained IPC focal points and 83.3% promoting a multimodal improvement strategy [19]. The subsequent high implementation of the IPC program is attributed to the outbreak of COVID-19 in 2020, which likely prompted various hospitals to implement IPC more actively. Both papers cover the healthcare settings in general, rather than RD in particular.

Therefore, our study provides valuable insights into the state of IPC practices within RDs in the AOR following COVID-19, highlighting strengths and areas for improvement. Our survey results revealed that a significant proportion (74.6%) of the respondents reported being aware of having a national IPC committee or program in place. However, only 68.9% of the institutional respondents were aware that they had a specific IPC policy tailored for the RDs. Among those with an IPC policy, more than half (50.8%) followed the WHO guidelines, while others adhered to local guidelines or had no formal policy in place. This variability highlights the need for standardized IPC practices in RDs to ensure consistency and safety across the region. One possible explanation for the high number of respondents with awareness of the IPC national program in our survey is that our study was conducted after the COVID-19 pandemic, when awareness of IPC was significantly heightened. Our findings are consistent with the WHO IPC 2024 global survey report, which examined active national IPC programmes (i.e., functioning programmes with an annual work plan and budget) and found that they existed in 71.3% (107 of 150) of the surveyed countries [19]. The pandemic prompted numerous improvements in IPC practices, according to our survey, with 85.2% (104/122) of RDs reporting the adoption of new infection control measures, including audits, multidisciplinary meetings, and the installation of negative pressure rooms.

Western guidelines from organizations such as the Radiological Society of North America (RSNA), the European Society of Radiology (ESR), and the American College of Radiology (ACR) provide a valuable context for assessing the findings from our study. The RSNA has long emphasized the importance of infection control in RDs, focusing on equipment disinfection, hand hygiene, and staff training [20]. These guidelines align with our findings, underscoring the importance of regular education and adherence to standardized infection control measures.

Similarly, the ESR's guidelines on IPC in RDs focus on areas such as patient screening, disinfection of imaging equipment, and the use of personal protective equipment. While the ESR's recommendations are broadly similar to those of the WHO, they are more detailed in addressing the specific IPC needs of RDs, particularly during invasive radiological procedures. Our study concurs with these findings, noting that procedures involving contrast injections, catheters, and power injectors pose unique infection risks specific to the radiology department [21].

The ACR also recommends implementing comprehensive infection prevention programs in imaging centers, advocating for staff training, equipment cleaning, and stringent protocols for high-risk procedures [22]. These practices, emphasized in the ACR guidelines, align with the proactive approach observed in some RDs following the COVID-19 pandemic. However, our survey also identified areas for improvement, particularly in screening practices and disinfection protocols, which remain highly variable across departments.

Our findings highlight the unique IPC challenges faced by RDs, which are often overlooked in comparison to other clinical areas. The high patient turnover, combined with the frequent use of invasive procedures (such as contrast injections and catheterizations), increases the risk of HAIs in radiology settings. Equipment such as needleless connectors and contrast injectors, commonly used in radiological procedures, has been identified as a high-risk point for infection transmission. [1, 23]. This highlights the need for specialized IPC standards for RDs beyond those in general healthcare settings.

Furthermore, the survey revealed that many respondents were radiologists, who typically do not have direct patient contact. However, IPC is the responsibility of all healthcare workers, and radiographers who interact with patients directly must be included in IPC programs and training. Radiographers often receive limited IPC training in their formal education, and extending IPC education to this group could enhance patient safety in RDs [24].

Ongoing education and promoting a no-blame culture within RDs ensure that IPC protocols are consistently followed. Training programs should address the technical aspects of infection control (e.g., hand hygiene and equipment disinfection) and emphasize the importance of reporting incidents without fear of blame. A culture encouraging open communication and continuous learning is vital for improving IPC practices and preventing future outbreaks [25].

The epidemiological disparities in HAIs, particularly between developed and developing nations, highlight the impact of various factors such as inadequate infrastructure, understaffing, and a lack of standardized guidelines [26]. These challenges contribute to the variability in IPC practices, underscoring the need for more robust national and institutional policies.

Just like ECR, RSNA, and ACR, AOSR, as a leading authority in the AOR, can play a role in uniting the various members by establishing a formal IPC specific to RDs at the institutional and departmental levels, which aligns with the WHO core components but adapts them to local contexts. Continuous engagement through educational initiatives, incorporating IPC training into radiology education curricula, mandating annual training for all staff, and promoting a no-blame culture to encourage reporting of IPC violations and near-miss events will strengthen practices in the RD [27]. AOSR can also play a role via a position statement to advocate for government and institutional support to enhance infrastructure and resource availability. AOSR can leverage regional collaboration to share knowledge, best practices, and resources, thereby enhancing its effectiveness.

This study provides valuable insights into IPC practices in RDs across the AOR; however, a few limitations should be noted. The survey did not encompass all institutions and RDs across the AOR, nor did it aim for proportional representation. It was based on voluntary participation at the convenience of potential respondents. Hence, the majority of responses were from Japan, Thailand, and Malaysia, reflecting their active participation in this survey. Consequently, the results may not fully represent the AOR but rather reflect the status of the participating institutions (see Supplement). These three countries, Japan and Thailand being developed nations, whilst Malaysia is a developing country, represent well-established healthcare systems in the region.

A more detailed, country-level analysis incorporating diverse and representative data from all countries is an essential goal for future studies. This will provide a more nuanced understanding of IPC practices across various healthcare settings. The categorization in one survey question—Private, Government, Academic, and Others—was not mutually exclusive, which could lead to inconsistencies in classification. Additionally, the survey did not include a question on hospital size or level (e.g., primary, secondary, tertiary), which limits understanding of how these factors impact IPC practices. These aspects should be taken into consideration when interpreting the findings. Unfortunately, this gap in the survey design constitutes a limitation that cannot be corrected retrospectively.

We also note that varied responses originated from the same countries. The survey was designed to explore knowledge gaps and variations in infection prevention and control (IPC) practices. Therefore, discrepancies between responses were considered meaningful and reflective of potential differences in awareness or implementation within the same institution. No attempt was made to reconcile such discrepancies, as these insights contribute to identifying internal inconsistencies and areas for improvement.

In conclusion, the survey highlighted the overall commitment to IPC in RDs across the AOR, with significant progress made in response to the COVID-19 pandemic. The findings provide valuable insights that can guide future improvements in compliance with IPC practices and their implementation across the region. Addressing policy implementation, training, and resource allocation gaps is critical for enhancing infection control practices. Standardizing IPC policies across departments and aligning them with national and international guidelines will improve consistency. Furthermore, enhancing staff education, particularly for radiographers, and ensuring adequate resources will strengthen IPC measures, providing safer and more effective radiology services. Continuous vigilance and adaptation to emerging infection risks are essential for maintaining high IPC standards in the radiology department.

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Case Report

Hemophilic pseudotumor of the skull: A rare presentation in a young child

Law Zhi Hou, M.D.[1]
Barbara Li Lian Kuok, Mrad.[2]
Normawati Mat Said, M.D.[2]
From [1]Department of Radiology, Hospital Sultanah Nora Ismail, Malaysia,
[2]Department of Radiology, Hospital Tunku Azizah, Malaysia.
Address correspondence to L.Z.H (e-mail: zhhlaw6@gmail.com)

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Abstract

Hemophilic pseudotumors are rare complications of severe hemophilia and typically involve muscles and bones. We present the case of a 1-year-old 5-month-old boy with severe hemophilia A, who developed progressively enlarging left occipital scalp swelling. A computed tomography (CT) scan revealed a significant left occipital osteolytic calvarial mass causing a mass effect and displacing the 4th ventricle. The absence of acute neurological compromise allowed for conservative management in this case. This case highlights the importance of considering hemophilic pseudotumors in patients with hemophilia, even in atypical locations. Early recognition and individualized management are crucial for optimal outcomes in patients with this challenging complication.

Keywords: Hemophilia, Hemophilic pseudotumor, Scalp, Skull.

Introduction

Hemophilia is a condition in which a deficiency in clotting factors causes coagulation defects. Hemophilia pseudotumors are rare complications of hemophilia [1]. It usually involves muscles of the pelvis or lower limb as well as bone involvement, most commonly involving the femur, tibia, pelvis or small bones of the hands [1]. Skull involvement is a rare occurrence [2]. We report a rare case of skull hemophilic pseudotumor and review its presenting illness, diagnosis and treatment.

Case summary

A 1-year-5-month-old Malay boy underlying severe hemophilia A and a history of recurrent intracranial bleeding complicated by right-sided hemiparesis and seizures presented to the hospital with a complaint of progressively enlarging left occipital scalp swelling (Figure 1). The swelling had been present for two months, initially growing rapidly but stabilizing in size for the past month prior to presentation. Despite the swelling, the child remained active and alert, without fever or signs of increased intracranial pressure.

Ultrasound was initially performed to evaluate the swelling. Ultrasound revealed a heterogeneous hypo-hyperechoic mass in the left occipital region with anechoic components. There was no intralesional vascularity. (Figure 2). It involved the subperiosteal region, with extension to the diploe of the occipital skull.

A computed tomography (CT) scan of the brain was subsequently performed in view of the presenting complaint. The findings revealed a significant left occipital osteolytic calvarial mass with inhomogeneous hyperdense attenuation associated with curvilinear deformed bone/calcification at the outer margin of the lesion and bone resorption in this region (Figure 3). This hematoma caused a mass effect, displacing and compressing the 4th ventricle with resultant hydrocephalus. Additionally, frontal lobe encephalomalacia was noted as a sequela of previous intracranial bleeding (Figure 4).

These imaging findings, which are correlated with underlying hemophilia, are suggestive of hemophiliac pseudotumors. Given that the patient remained active with no sign of increased intracranial pressure, the patient was treated conservatively and monitored for any sign of increased intracranial pressure. This patient did not receive treatment for factor replacement due to a financial constraint. The patient was subsequently on a palliative treatment. No follow-up imaging was performed.

Figure 1. *Large left occipital scalp swelling on presentation.*

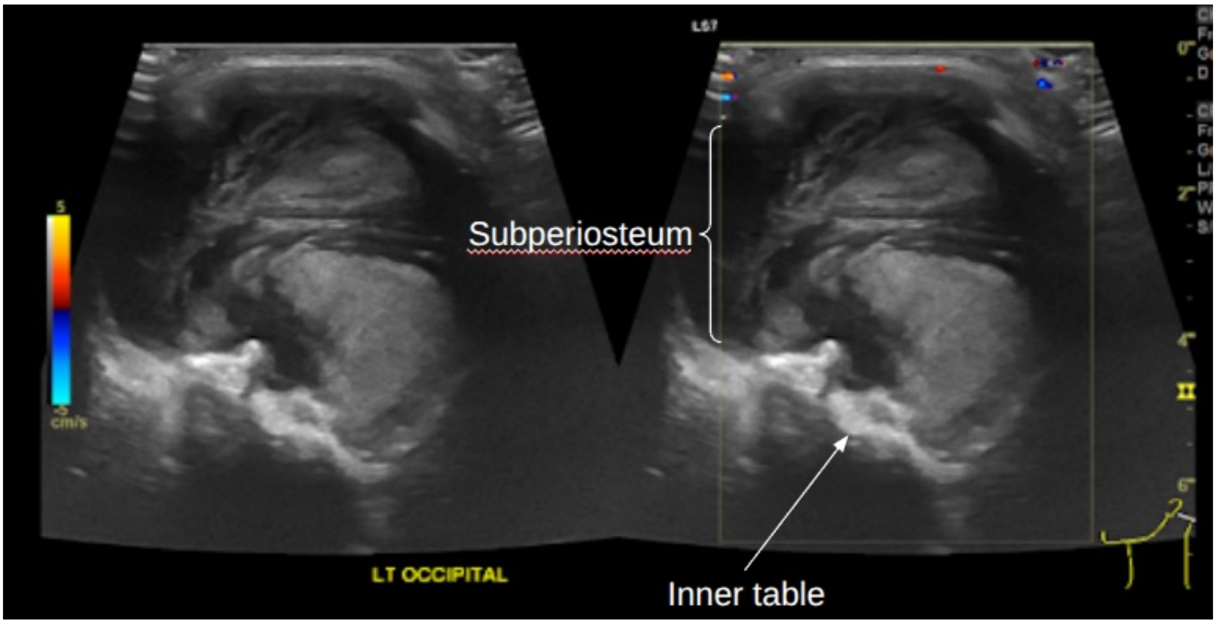

Figure 2. *Ultrasound image shows (A) grey scale, (B) with color Doppler showing a heterogeneous hypo-hyperechoic mass in the left occipital region with an anechoic component involving the subperiosteal region (shown by bracket), with extension to the diploe of the occipital skull. There was no intralesional vascularity.*

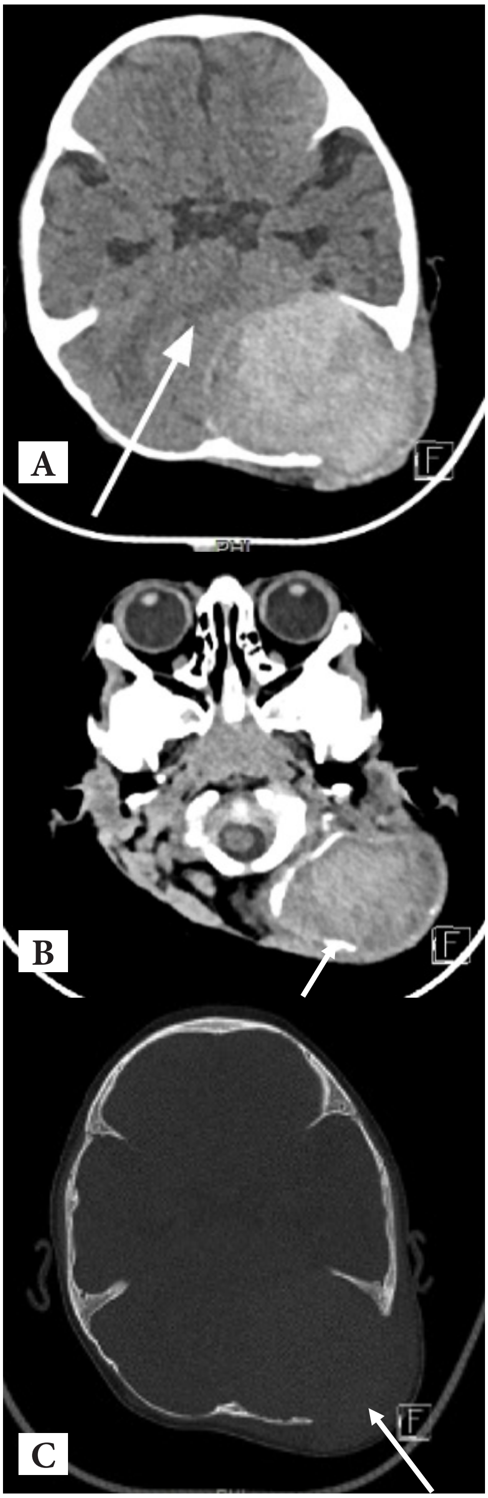

Figure 3. *(A) Large hyperdense mass in the left occipital region suggestive of a pseudotumor causing compression of fourth ventricle (white arrow) (B) curvilinear deformed bone/calcification (white arrow) noted at the outer margin of the mass (C) Expansion of the inner and outer table at the left occipital region with associated cortical thinning and bony resorption (white arrow) around the mass.*

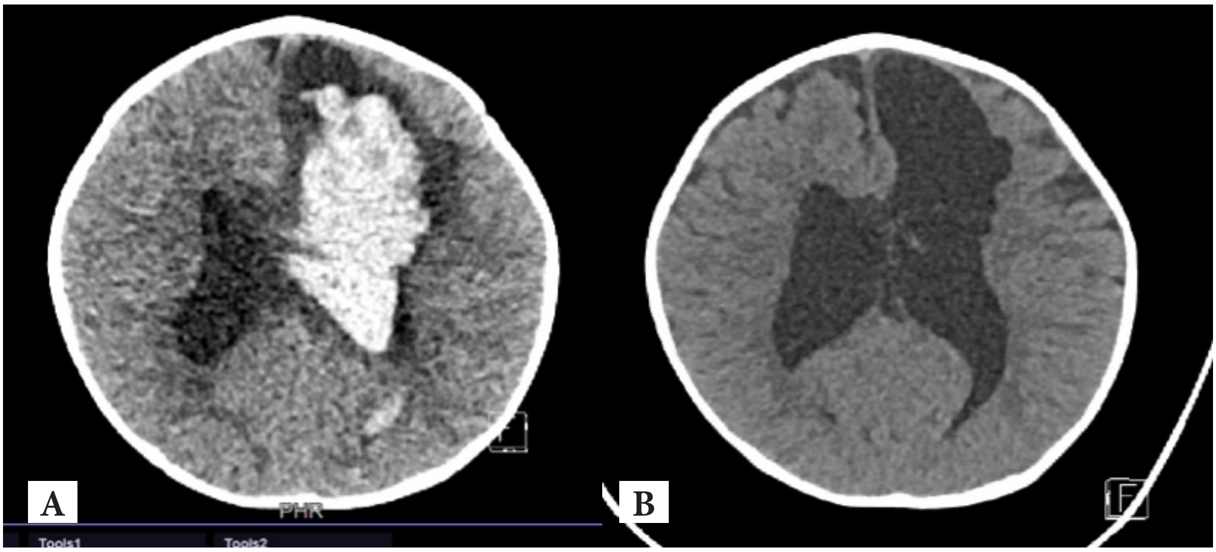

Figure 4. *(A) CT brain performed 17 months prior to current presentation shows left frontal intraparenchymal bleeding (white arrow) with intraventricular extension and hydrocephalus (black arrows). (B) Current CT noted evidence of left frontal encephalomalacia in the corresponding region.*

Discussion

Hemophilic pseudotumors are rare complications of severe hemophilia, arising from the insidious accumulation of blood within the muscle or bone due to recurrent bleeding episodes [1]. These conditions, affecting less than 2% of individuals with severe hemophilia, manifest clinically with a wide range of symptoms depending on their location and size [2]. It usually involves muscles of the pelvis or lower limb as well as in the case of bone involvement, most commonly involving the femur, tibia, pelvis or small bones of the hands [2]. Skull involvement is a rare occurrence [3,4,5]. There are limited number of case reports on skull hemophilic pseudotumor especially in pediatric population. The youngest patient with this condition in our literature review is reported by Horton et al (1993) which involve a 12-month-old American Indian boy [6]. Depending on their location, these pseudotumors can cause various complications. As their sizes increase, they can compress into nearby anatomical structures, causing symptoms. In our case, it presented as a left occipital 'mass', which is a rare site of involvement that causes a mass effect on the surrounding brain structure.

Radiological imaging, encompassing X-rays, CT and magnetic resonance imaging (MRI), plays a crucial role in diagnosing and characterizing these lesions. X-rays are particularly valuable for accessing intraosseous pseudotumors, revealing their characteristic lytic, expansile nature, which is often accompanied by cortical changes and periosteal reactions [7-8]. Ultrasound can demonstrate the presence of fluid within the pseudotumor [1] as well as progression after treatment, particularly in the case of soft tissue pseudotumor [2]. In our case, ultrasound revealed a heterogeneous mass with anechoic components. CT and MRI offer comprehensive insights into its extent, composition, and relation to adjacent structures [1]. In the case of intraosseous involvement, CT is particularly useful for evaluating crossing trabeculae, cortical changes, and periosteal reactions. MRI has a remarkable ability for assessing intramedullary portions and nearby soft tissue (neurovascular bundle) as well as monitoring the therapeutic response. The characteristic MRI appearance is an intramedullary cystic lesion containing fluid components, which have complex signal intensities reflecting the effects of remote and recurrent hemorrhage and clot organization [2]. In our case, CT was able to characterize the lesion, revealing its extension and mass effect on the surrounding structure and eventually providing an accurate diagnosis that was correlated with the underlying condition.

Other possible differential diagnoses with solitary soft tissue lesions with bone erosion include neuroblastoma one metastasis as in Hutchinson syndrome. However, this condition usually appears as a multiple area of bone metastasis [9]. Figure 5 depicts an instance of neuroblastoma metastasis, manifesting as multiple osseous lesions [10]. In terms of imaging, MRI for hemophilic pseudotumor shows T1W/T2W peripheral hypointense rim representing fibrous tissue that contains hemosiderin which is not seen in Hutchinson syndrome. A combination of the given history of hemophilia and imaging features, biopsy should be avoided in these patients [11]. In our case, the presence of underlying Hemophilia A with a solitary soft tissue mass in the skull best fit the diagnosis of hemophilic pseudotumor even though no MRI imaging was performed.

The management approach primarily focuses on prevention through meticulous control of bleeding episodes with a factor replacement therapy and other conservative measures [1]. However, for established pseudotumors, a multipronged therapeutic strategy may be needed, encompassing options such as low-dose radiotherapy, percutaneous curettage, surgical resection, or even filling the resultant cavity with a bone graft or other suitable materials [7]. In our case, the patient was treated conservatively with further monitoring for any sign of increased intracranial pressure.

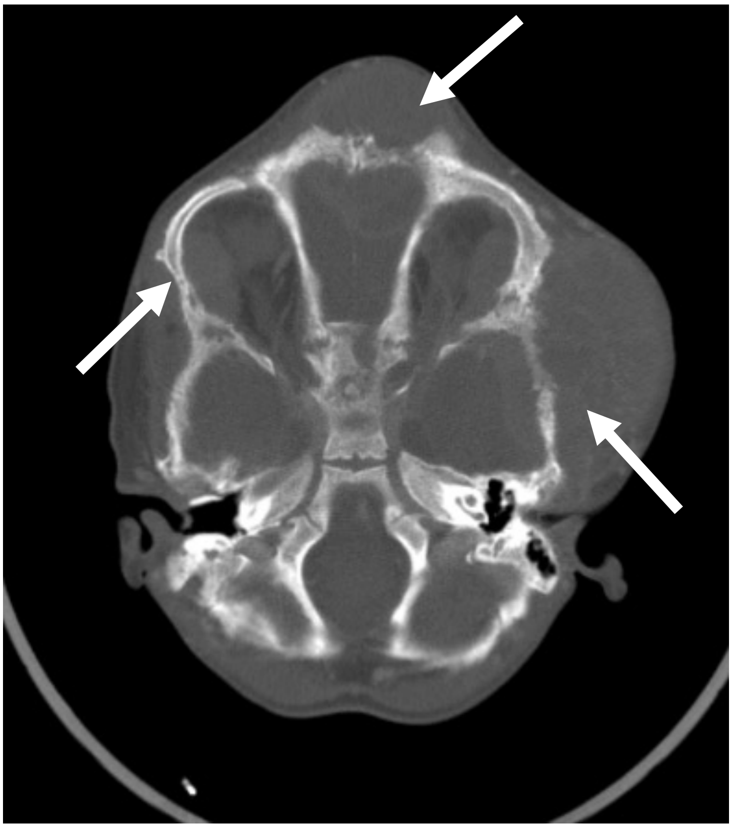

Figure 5. *Multiple osseous lytic metastases of neuroblastoma in skull base and calvarium (arrows) - Case courtesy of Ahmed Abdrabou, Radiopaedia.org, rID: 32540 [10]*

Conclusion

This case highlights the rare but significant complication of hemophilia pseudotumor in a young boy with severe hemophilia A. His presentation with progressively enlarging scalp swelling and subsequent CT findings emphasized the importance of considering this diagnosis in patients with hemophilia, even in unusual locations such as the skull. While rare, hemophilic pseudotumour remains a challenging complication, necessitating a high index of suspicion, prompt diagnosis, and multidisciplinary management to optimize patient outcomes. However, with the presence of a history of Hemophilia, typical presentation and imaging findings, particularly MRI which shows peripheral rim of T^1W and T^2W hypointensity, biopsy should be avoided. Further research and awareness are essential to improve the understanding and management of this rare entity.

Conflict of interest: The authors declare that they have no conflicts of interest.

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Pictorial Essay

X-ray photography at Cambodian refugee camps on the Thailand - Cambodia border around 1980

Katsumi Tsujioka, R.T.
From School of Medical Sciences, Fujita Health University. Toyoake, Aichi, Japan.
Address correspondence to K.T.(e-mail: tsujioka@fujita-hu.ac.jp)

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Keywords: Cambodian refugees, Japan International Cooperation Agency (JICA), Medical care, Refugee camps, The border between Thailand and Cambodia.

Overview

In the late 1970s, the news of Cambodian refugees in Indochina was prevalently reported around the world. At that time, in 1978, I had graduated from the Radiological Technologist School at Nagoya University in Japan and had just started working as a radiological technologist at what is now Fujita Health University Hospital. I had been concerned about Vietnam and Indochina since I was in high school, but I felt that it was a problem in a country far away from me. However, in 1980, my relationship with Indochina began. In December 1980, I received an urgent request from the chief technologist of the university hospital. "Is there anyone who would like to go to the Cambodian refugee camp on the Thailand and Cambodia border?" It was a request to participate as a member of a Japanese medical team in a Japan International Cooperation Agency (JICA) project. Since I had been interested in overseas activities, I applied to join the refugee relief medical team that very same day. One week later, I was on my way to Thailand.

At that time, I had only one year of experience as a radiological technologist and could not speak English. I boarded the plane with only some textbooks on X-ray photography and a compact English dictionary. In fact, this was the first time flying, meaning it was also my first time abroad. One day after arriving at the

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airport in Bangkok, I went to Sa Kaeo City near the Cambodian border. For three months, from December 1980 to March 1981, I worked as a radiological technologist on JICA's Cambodian Refugee Relief Medical Team. The other members were doctors, nurses, and a medical technologist from Tokyo Medical and Dental University and Okayama Saiseikai Hospital. Our JICA team was based at the Japan Medical Center in Sa Kaeo City, and in two refugee camps: Khao I Dang Camp, north of Aranyaprathet, and Bang Kaen Camp, west of Sa Kaeo City (Figure 1).

Figure 1. *Thailand-Cambodia border,* *the JICA team's activity sites; the Japan Medical Center (JMC) in Sa Kaeo City was the center of medical activities at two refugee camps, Khao I Dang Camp and Ban Kaeng Camp, and Crown Prince Hospital in Sa Kaeo City.*

Khao I Dang Camp

The Khao I Dang Camp is located a few kilometers from the Cambodian border, and there was a world-famous refugee camp at the time. The refugee camp was vast, with more than 160,000 refugees. Medical teams participated from all over the world, including France and Germany, in addition to Japan (Figure 2). Our JICA team operated the outpatient department and ward of Japanese Hospital, but the international team was in charge of X-ray photography. Figure 3 shows the examination room in Japanese Hospital. Figure 4 shows the ward of Japanese Hospital. The patients are lying on simple beds. Medical records and X-ray films were hanging above the patients' beds. The hospital was made of simple palm leaves, and the walls are very simple. Although it appears white in the photo, you can see the outside. When the wind blows, the ward is covered in sand. In Khao I Dang Camp, minor surgeries are performed in the refugee camp's operating room, but major surgeries are transported to the Japan Medical Center, about which I will explain later, where patients are admitted and operated on. Figure 5 shows the refugee home.

Figure 2. ***International Hospital Street in Khao I Dang Camp;*** *Khao I Dang Camp was located near the Cambodian border and housed 160,000 refugees. This photo shows the hospital street in the refugee camp. The hospitals were run with support from the International Red Cross and countries around the world. Each hospital was made of palm wood.*

Figure 3. *Examination room at a Japanese Hospital;* *doctors and nurses were busy in the examination room and patients were arriving one after another.*

Figure 4. *The ward of Japanese Hospital;* *patients were lying on simple beds. Medical records and X-ray films were hanging above them. The buildings were very simple, with well-ventilated walls.*

Figure 5. ***Refugee housing;*** *refugees lived in simple houses made of palm wood leaves, one for each family.*

Ban Kaeng Camp

Ban Kaen Camp was located near the Japan Medical Center, north of Ban Kaen Station on the State Railway of Thailand (Figure 6). It seems that the last scene of the movie "The Killing Fields" was filmed there. There were tens of thousands of refugees in Ban Kaen Camp. Because Ban Kaen Camp is relatively small in scale compared to Khao I Dang Camp, refugee relief medical care was provided only by the JICA team. I was the main X-ray taker here, and assisted several refugees. Undoubtedly, they were unlicensed. The X-ray device was self-rectifying, with tube voltage of 100 kV and tube current of about 20 mA. One used fluoroscopy device was sent from Bangkok, but it was broken and did not work. We started by sticking lead plates to the walls of the X-ray room (Figure 7). There were problems such as the X-ray localizer not lighting up and the X-ray collimator not working, but we managed to handle the contingency and take matters into our own hands. The film was tank-developed. It was hot and humid. The developer was old and the film was not stored well. Although the images were not satisfactory, we were somehow able to interpret them. The quality of medical care can change dramatically depending on whether or not we have an X-ray. I worked with the pure intention to help these people who had experienced terrible things as refugees (Figure 8).

Figure 6. ***Ban Kaen Camp*** *was located the west of Sa Kaeo City. The medical care at Ban Kaen Camp was handled only by the JICA team.*

Figure 7. ***Construction of the radiography room;*** *three refugee helpers and I constructed many lead plates for the radiography room ourselves.*

Figure 8. ***Prosthetic limb section for people who lost legs due to landmines;*** *the man looked ecstatic to receive a new prosthetic limb.*

Japan Medical Center

The Japan Medical Center (JMC) was located the west of Sa Kaeo City. It was a facility built for our JICA team, and had wards, a consultation room, an operating room, an examination room, an X-ray room, and accommodation for the JICA team (Figure 9). There was also a mobile bus for chest examinations provided by Japan. The X-ray equipment included a Shimadzu self-rectifying device and a fixed focus X-ray tube, with a tube voltage of 100 kV and a tube current of 20 mA. Because the tube current was small, it took 1 to 2 seconds to take a chest image and 3 to 4 seconds to take an abdominal image (Figure 10). The exposure time was set by a clockwork mechanism. Therefore, the first Thai and Khmer words I learned were "Take a breath and hold it," "Don't move," and "Finish."

The Japan Medical Center had a room for X-ray, but no darkroom for film development. The person previously in charge seemed to have developed the images in the shower room, but it was very difficult to use. Therefore, I created a new darkroom by using the space next to the JICA coordinator's office. Films were developed in a tray. It was from December to March in Thailand, so there were days when the temperature exceeded 40 degrees and the development temperature exceeded the target of 33 degrees. Therefore, I devised a way to double the developing tray and running water on the outside tray. After that, since it was a manual development, the film density could be roughly adjusted by the development time. Today's radiological technologists are not trained this way, but at the time, Japanese radiological technologist schools were even trained in the film development method. This knowledge was very useful at the refugee camp. At the Japan Medical Center, we also took intraoperative X-rays of patients transported from the refugee camp. For intraoperative radiography, A colleague from JICA, who was about the same height as I am, and I carried a long pole and hung the X-ray tube in the center to take X-ray images. Most of the patients had metal pieces removed from landmine explosions. There were also other diseases. Figure 11 shows the upper gastrointestinal (UGI) imaging being taken. There was no fluoroscopy device, so it was a ‘blind’ UGI. I took the images while imagining the anatomy of the stomach and the position of the contrast agent.

Figure 9. ***Japan Medical Center (JMC)*** *was located in the west of Sa Kaeo City. It was the base and accommodation for the JICA team as well as functioned as a hospital. Hospitalization, surgery, various examinations, and X-rays were possible. This facility is currently used as a malaria research facility in Thailand.*

Figure 10. ***X-ray control device;*** *tube voltage was 100kV; tube current was 20mA, and the exposure time was 0.1 to 10 seconds.*

Figure 11. ***Taking upper gastrointestinal (UGI) X-ray;*** *the patient lay on the floor to keep the distance between the X-ray tube and the film. The UGI was performed blind. I am wearing a protective apron.*

Crown Prince Hospital in Sa Kaeo City

In Sa Kaeo City, where the Japan Medical Center was located, there was a Thai hospital called Crown Prince Hospital (Figure 12). In addition to refugee relief medical activities, the JICA team also provided medical cooperation to Crown Prince Hospital. They accompanied local medical activities outside the hospital. Chest examinations were performed using a chest X-ray examination vehicle at the Japan Medical Center (Figure 13). The examination vehicle used indirect photography with an image intensifier (I.I.). Images were taken on a 100 mm wide roll film which were then developed at the hospital.

In 1980, CT was introduced in Japan and digitalization of images began, but when I asked a radiologist at Crown Prince Hospital at the time what he needed, the answer was he wanted a stabilized power supply rather than a CT. At that time in Thailand, there was a problem of large voltage fluctuations, which made it difficult to perform stable X-ray photography.

Figure 12. ***Crown Prince Hospital in Sa Kaeo City;*** *this is a hospital, not a safari park.*

Figure 13. *Local mobile screening by X-ray bus provided by Japan.*

45 years have passed

I worked on refugee relief activities on the Thailand-Cambodia border from 1980 to 1981. After that, in 2000, I took part in establishing a medical physics department at the request of Dr. Anchali Krisanachinda from Chulalongkorn University in Bangkok. After that, I visited Chulalongkorn University and Prince of Songkla University and was involved in educating radiological technologists and medical physicists.

In 2024, I revisited Aranyaprathet, Sa Kaeo City and Khao I Dang on the Thailand-Cambodia border for the first time in 45 years. The Khao I Dang refugee camp, where more than 160,000 refugees lived, had become a quiet wilderness with no one around. Aranyaprathet and Sa Kaeo had been transformed into new towns. A new building was constructed at Crown Prince Hospital (Figure 14). The Japan Medical Center had become a Thai malaria research facility. It really felt like a dream to be back after 45 years.

Figure 14. ***Crown Prince Hospital 45 years later;*** *the safari park hospital has been transformed into a modern hospital.*

My activities in Thailand and Asia

Currently, I am conducting education and research on CT in Japan. Also, in Southeast Asia, mainly in Thailand, I am promoting radiation education, including CT. Society has prominently changed since the time of the Indochina refugees. The development of radiological technology is ongoing. We, radiologists around the globe, remain active and it is important that medical staff in many countries cooperate and develop alongside one another. I aspire to continue to contribute, for the sake of people's sustainable happiness.

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Perspectives

Radiology in India stands at the crossroads: Friends, foes, and the future

Lokesh Rana, M.D.[1]
Pooja Gurnal, M.D.[2]
Dileep Chowdary, M.D.[1]
From [1]Departement of Radiology and [2]Department of Anesthesia, AIIMS, Bilaspur (H.P.), India.
Address correspondence to L.R. (E-mail: poojalokesh2007@gmail.com)

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Abstract

Radiology is one the most important and rapidly evolving modern diagnostic fields. It is facing significant challenges which makes it stand on crossroads in India. Regulatory pressures, technological shifts, and inter-specialty tensions pose real threats. While new technologies like Artificial Intelligence (AI) and teleradiology offer promising advances, they are accompanied by regulatory hurdles, professional encroachments, and workflow disruptions.

Keywords: Artificial intelligence, Communication, Malpractice, Medical errors, Radiology, Risk Management.

Introduction

Radiology, as a cornerstone of modern diagnostics, is evolving rapidly-but not without facing significant challenges. In countries where cultural and religious beliefs glorify male children to great extents, cases of female foeticide are prevalent. With the introduction of the pre-conception and pre-natal diagnostic techniques (PC-PNDT) act which prohibits sex detection of foetuses has significantly improved the trends towards female child sex ratio but the provisions of the act put radiologists under a constant threat of violation. Even a minor clerical mistake can be a cognizable, non-bailable, and non-compoundable offence; therefore, this aspect of the act needs attention from law makers [1]. The widespread adoption of teleradiology enhanced the reach of radiology services to underprivileged and remote areas but the lack of parity in reimbursement to radiologists calls for need for national and international standardisation of this service. The various clinical departments especially super and sub specialities consider imaging in their respective fields as part of their domain and radiologists need to reclaim their relevance by enhancing their clinical and communication skills. In this write-up, we also highlighted another challenge which a practising radiologist encounters i.e. kickbacks, how making the approach patient-centric can eliminate middlemen. Another problem within the Indian setup is the mushrooming of private colleges and the consequent increase in MD seats, which is diluting the prospects for radiologists and undermining the integrity of the profession Radiology is evolving at an exponential pace with the advent of Artificial Intelligence, so the adoption and clinical integration of AI is the future [2]. The future with all anticipated caveats is promising for this field provided we change our education system as well as the training of young radiologist by involving them in the emerging era of Artificial intelligence. Although these new technologies like Artificial Intelligence (AI) and teleradiology offer promising advances, they are often accompanied by regulatory hurdles, professional encroachments, and workflow disruptions [3]. This editorial explores the key challenges and opportunities shaping the present and future of radiology in India.

The PC-PNDT Act: An Ethical Shield or a Legal Burden?

Challenges

The Pre-Conception and Pre-Natal Diagnostic Techniques (PC-PNDT) Act came into effect in 1994 at a time when illegal foetal sex determination was rampant, with some ultrasound reports guaranteeing the sex of the foetus. The alarming decline in the sex ratio necessitated strict legislation. The Act was amended in 2003 and 2011 to tighten its enforcement [4]. However, its implementation has often been seen as harsh— as radiologists are presumed guilty until proven innocent, a principle contrary to basic legal norms in the Indian Penal Code [5]. This has emerged as a major cause of professional stress among Indian radiologists [6].

Mitigation

Radiologists must be fully aware of their legal obligations under the Act. Simultaneously, there should be widespread public awareness about gender equality, the social evil of dowry, and the misplaced pride in having a male child. While the Act may have limitations, radiologists must strictly comply with its provisions to uphold its intended purpose [7]. A possible long-term solution is to shift focus towards tracking and protecting female foetuses throughout antenatal and perinatal care, ensuring that the Act's original intent is achieved through positive reinforcement and accountability.

Teleradiology: Expanding Access or Eroding Standards?

Challenges

Teleradiology has made it possible to extend radiology services to underprivileged and remote areas, but its implementation in India has been far from ideal. In practice, it often translates to underpaid and high-volume reporting with suboptimal reimbursement. This economic model encourages overreporting with reduced quality and professional burnout [8,9]. Additionally, the absence of direct patient interaction and real-time discussions with clinical teams compromises comprehensive patient management, especially in complex cases [10].

Mitigation

Globally, teleradiology is an accepted and growing practice, and also in India, it plays a key role in improving healthcare access. However, it must be integrated into hospital-based systems without displacing radiologists from clinical roles [11,12]. Workload distribution, structured reimbursement models, and quality assurance mechanisms can transform teleradiology from a cost-cutting tool into a quality-enhancing solution.

Clinical Specialty Impingement: Collaboration or Competition?

Challenges

Subspecialties such as obstetrics, neurology, and gastroenterology increasingly rely on in-house imaging capabilities, sidelining radiologists. These clinical departments consider imaging in their respective fields as part of their domain. At the same time, radiologists are retreating from clinical discussions, often due to excessive workloads and lack of updated clinical knowledge [13,14].

Mitigation

To reclaim their relevance, radiologists must enhance their clinical understanding and communication. Sub-specialization within radiology is essential to match the depth of knowledge in clinical departments. Diseases often span multiple organ systems and require multimodality imaging expertise—something only trained radiologists can provide [13]. Collaboratively, patient-centered care should be the goal, rather than siloed practice.

Elephant in the Room: Culture of Cut-Practise

Challenges

As radiology is dependent on clinical branches to refer patients to a radiologist, this system is highly abused by referring doctors. No patient will be referred to you unless you give a substantial amount in the form of kickbacks to the referring doctor in some cases the kickbacks can be as high as 50 percent of the total cost of the imaging modality, whether it is X-ray, ultrasound, CT or MRI.

Mitigation

If competence is equal, one clear differentiator could be pricing—charging less and passing the savings on to patients. Another is developing a more patient-centric and engaging practice, prepare personalized reports, or send tailored WhatsApp/SMS messages to the patient [15].

Artificial Intelligence: Threat or Ally?

The Hype

In 2016, AI pioneer Geoff Hinton predicted that radiologists would become obsolete within five years. This prediction has not materialized, for which later he publicly acknowledged his mistake in 2025 [16]. Dr. Nicola Strickland, Past President of the Royal College of Radiologists from 2016-2019, more realistically advised focusing AI development on “low hanging fruit” like normal chest X-rays. In 2021, Dr Paul J. Chang, a professor of radiology and a vice chairman of Radiology Informatics at the University of Chicago, described the state of the landscape for implementing Artificial Intelligence (AI) in radiology as a ‘trough of disillusionment’ [17]. AI has undeniably improved workflow and reduced repetitive tasks like lesion measurements [18], but interpreting images in isolation does not constitute practicing radiology.

The Reality

Radiologists’ role go beyond image interpretation. It involves clinical judgment, communication with referring physicians, and integrating multiple data sources to form a diagnosis. Appropriate communication is becoming more and more important in the current era of application of generative Artificial Intelligence to the radiological world [19]. AI, often trained on single-modality inputs like X-rays or CT scans, lacks the nuanced understanding of patient history, physical findings, and lab results that human clinicians routinely use [20].

For example, post-surgical intracranial haemorrhages can be misinterpreted by AI and pulmonary embolism detection has failed in up to 10% of preliminary AI assessments [20]. Current AI models are based on convolutional neural networks (CNNs) that work on image pixel values. Even basic patient demographics are frequently omitted from AI pipelines [20].

The Way Forward

Radiology systems like HIS and RIS are evolving to enable integration of electronic medical records, pathology, biochemistry, and imaging. This creates opportunities for holistic AI-powered tools that support—rather than replace—radiologists [21-24].

With radiologists interpreting between 10,000 to 15,000 images per shift, fatigue and diagnostic errors present actual concerns [21,22]. However, AI should focus on complementing radiologists through better data aggregation, structured reporting, and bidirectional communication between radiologists and clinicians [25].

A correct clinical history and context provided in imaging requisitions dramatically improve reporting accuracy, while poor-quality information can lead to harmful misinterpretations [22-27].

Ultimately, AI is a tool—not a competitor. A picture may be worth a thousand words, but when those words are structured, informed, and contextualized, they become invaluable to patient care. According to the Summary of the Proceedings of the International Forum 2021, instead of making the radiologists obsolete, AI will allow them to reposition themselves and increase their visibility by positioning them technology leaders in the inevitable change that will affect the whole of medical profession [28].

Conclusion

Radiology in India stands at a complex crossroad. Regulatory not only pressures, technological shifts, and inter-specialty tensions pose real threats—but also creates opportunities for reinvention. A proactive approach that balances compliance, specialization, and technological integration can redefine a radiologist's role. In this landscape, a radiologist is not a passive image interpreter but a clinical partner, data integrator, and patient advocate—supported, not replaced, by machines.

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ASEAN Movement in Radiology

A pulse check on environmental sustainability awareness in Asia-Oceania

Evelyn Lai Ming Ho, M.B.B.S., M.Med.[1]
Danny Hing Yan Cho, M.B.B.S., F.R.C.R.[2]
Chamaree Chuapetcharasopon, M.D., M.B.A.[3]
Noriyuki Tomiyama, M.D., Ph.D.[4]
From [1]Imaging Department, ParkCity Medical Centre Kuala Lumpur, Malaysia,
[2]Department of Diagnostic & Interventional Radiology, Kwong Wah Hospital, Hong Kong SAR,
[3]MedPark Hospital, Bangkok, Thailand,
[4]Department of Diagnostic and Interventional Radiology, Graduate School of Medicine, Osaka University, Osaka, Japan.
Address correspondence to E.L.M.H. (e-mail: evelynlmho@gmail.com)

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Introduction

The Asian Oceanian Society of Radiology (AOSR; https://theaosr.org) is primarily a federation with 24 regional society members and a small number of individual members globally. AOSR is diverse from many aspects and includes two of the most populous regions in the world, India and China and includes members from countries ranging from Oman to Tonga. The society members are from lower-middle; upper-middle and high-income countries/regions. Some of the AOSR objectives are steps that ultimately improve public healthcare including enhancing the quality and techniques of radiological procedures among our members. In 2021, the AOSR added value-based radiology (VBR) [1] and by 2024, sustainable radiology to its agenda.

Sustainable radiology—also known as eco-radiology or green radiology—seeks to reduce the ecological footprint of radiology departments whilst optimizing efficiency. This approach aims to minimize the environmental impact of radiological technologies and procedures, aligning with broader sustainable healthcare initiatives [2]. Imaging services, particularly radiology, are considered major contributors to the ecological footprint due to their high energy-consuming devices [3] and generated waste especially, though not exclusively, by interventional procedures [4].

Lower- and upper-middle-income regions/countries (LMICs) have none to low density of high-energy consumption modalities, such as computed tomography (CT) [5] and magnetic resonance imaging (MRI) scanners [6], let alone advanced interventional radiology services that most high-income economies have [7]. Basic diagnostic services such as radiography and ultrasound have significantly lower greenhouse gas (GHG) emissions [3]. Therefore, the ecological footprint of LMICs is expected to be lower. However, the environmental impact of radiology, no matter how small, does contribute to negative consequences on the climate, which disproportionately impacts lower-resource regions of the world [1]. Therefore, environmental sustainability is not the problem of high-income regions only.

Overuse or inappropriate imaging occurs globally even in lower-middle income countries/regions [8,9]. Travel for imaging, especially when unnecessary can be a significant burden on patients, particularly those who must walk for days to reach a medical centre, and may also contribute to environmental impact if the travel involves vehicles running on petrol. In addition to the ecological footprint, inappropriate imaging is contributing to higher costs for care [10] and straining the workforce shortage with its untoward consequences of moral distress to burnout [11].

AOSR's Pulse Check

The AOSR has since 2021 held a presidents' round table chat with its society members which is also open to the few individual members. These are conducted online, but it has been challenging to find a time that cater for most of its members. Instead, a short questionnaire with open-ended questions was circulated to the society secretariats and the 6 individual members in the middle of July 2024. The AOSR enquired about the presence of sustainability programs, policies in the department or hospitals, needs and challenges in relation to sustainability as well as whether their radiological society had taken any steps to promote sustainability.

17 of the 24 (71%) AOSR society members (either president or authorized delegate) and 3 of the 6 individual members responded. Each response represented a different country/region. These represented 7 lower-middle, 6 upper-middle and 7 high-income economies (World Bank Gross National Income, 2023): Australia, China, Chinese Taipei, Fiji, Hong Kong SAR, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, South Korea, Thailand, Tonga, Uzbekistan, Vietnam and "North America" (1 individual member).

About a third of respondents had sustainability programs in their department whilst 40% reported their hospital/medical centres had some policies whilst 25% were not aware if there were such policies. 15% and 20% reported programs were in the planning phase at the radiology department and hospital level respectively. At the radiological society level, 65% had either promoted or taken steps on sustainability.

About 2/3 of our respondents felt there was a need for sustainability guidelines and policies for waste reduction, more diligent stock keeping, better energy efficiency, going paperless, inappropriate imaging/procedures reduction, procurement of equipment such as low-helium scanners and more effective financial reporting and governance. There were also funding, access to innovation and infrastructure needs for 27% of the respondents. Use of radiology equipment to the maximum was considered a drawback as one could not purchase new equipment with eco-friendly features.

The challenges cited were a lack of awareness (one respondent mentioned this was the first time hearing about sustainability in radiology); insufficient training for staff on sustainable practices; lack of interest or buy-in regarding sustainability; balancing limited resources with growth and safe practices; ensuring adequate patient care and medicolegal concerns; digitalisation and artificial intelligence (AI) also had a high carbon footprint; balancing waste reduction with the use of single-use items for infection control purposes. In private centres, the tension between profit and avoiding unnecessary imaging was also noted. In addition, there was a lack of government and management support and problematic maintenance of digital platforms. Slow progress in sustainable initiatives were considered discouraging. Finally, there was a lack of data and research on whether specific steps taken were effective as well as the need to explore intelligent solutions to reduce energy consumption and GHG emissions.

Some of the activities by radiological societies were as follows. At congresses, there was usage of eco-friendly badges and non-disposable tumblers, a no-plastic bag policy, reduction of hardcopies through electronic publications and presentations and working with vendors to go green in booth construction. Other activities included planning dedicated workshops to set up a national standard operating procedure in collaboration with the ministry of health. They also conducted continuous medical education and activities on sustainability throughout the radiology community and promoting the use of electronic logbooks for examinations and training. Specifically, one society was actively promoting optimization of imaging protocols to reduce unnecessary repeat scans/examinations, (thereby lowering energy consumption and patient radiation doses) and awareness on environmental pollution through proper handling of medical/radiology waste and use of recyclable materials.

AOSR: Where Are We?

As expected there was a diversity of awareness and knowledge on sustainable radiology practices amongst our AOSR members - from zero awareness to conducting research to ensure measures taken had a desirable impact or to explore solutions to reduce the ecological footprint. The needs and challenges were not entirely new and not limited to sustainable radiology. One interesting comment was related to the medicolegal implications of using an appropriate but lower GHG emission imaging modality instead of a perceived "better" but higher GHG emission imaging modality. Non-radiologist referring physicians and public perception should to be taken into account and acted upon with education, if the medical imaging community is to make strides in the area of appropriate use. Paradoxically, whilst some felt a drawback was the need to use their equipment to the maximum capacity because of lack of funds, maximising and extending the lifespan of equipment is actually one of the tenets for sustainable equipment ownership. Having upgradeable components is important but ultimately, it is to reduce the need for new equipment.

Conclusion

There is an obvious need to continue to raise awareness, educate all stakeholders in the medical community and also reassure the public that appropriate and sustainable radiology does not short-change or lower the standard of care. Data compilation and research should be encouraged even though there are already publications on radiology's GHG emissions and strategies to develop sustainable practices, many from high-income regions. To this end, international exchange of knowledge and experience would ensure AOSR members do not 'start from scratch' or 'reinvent the wheel'. However, it is vital to ensure solutions are tailored to each country/region's need as the resources and other factors such as political and socioeconomic conditions are varied. Developing cooperation with various agencies such as the environmental protection agency is a gradual process. Even if a government or hospital management policy or directive does not exist, everyone can start practicing sustainable radiology. It can be as simple as turning off computers when not in use!

Following this pulse check, the AOSR formally established a sustainability working group in September 2024 and also collaborated with the society host of the Asian Oceanian Congress of Radiology (AOCR2025, January 2025) to initiate a track in sustainability.

Conflicts of Interest and Source of Funding:
The authors are current or past officers of the Asian Oceanian Society of Radiology: past president (Evelyn Lai Ming Ho), president-elect (Danny Hing Yan Cho), president (Chamaree Chuapetcharasopon) and immediate past president (Noriyuki Tomiyama) at the time of this writing. Otherwise, all authors have no conflicts of interest to declare.

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ASEAN Movement in Radiology

Thailand is implementing artificial intelligence to assist interpreting chest radiographs in public health

Wiwatana Tanomkiat, M.D.(1), (6)
Sitthichok Chaichulee, Ph.D.(2), (6)
Thammasin Ingviya, M.D., Ph.D.(3), (4), (6)
Supharerk Thawillarp, M.D., D.P.H.(5), (6)
From (1)Department of Radiology, (2) Department of Biomedical Sciences and Biomedical Engineering, (3) Department of Family and Preventive Medicine,
(4) Department of Clinical Research and Medical Data Science, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, Thailand,
(5) Epidemic Intelligence Unit (EIU), Department of Disease Control, Ministry of Public Health, Nonthaburi, Thailand,
(6) The Royal College of Radiologists of Thailand, Bangkok, Thailand.
Address correspondence to W.T. (e-mail: twiwadha@hotmail.com)

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Background

According to World Health Organization (WHO), six out of top ten causes of death worldwide are in the thorax, three of which are communicable and the other three are non-communicable [1]. The communicable ones are tuberculosis, pneumonia and COVID-19, of which a chest radiograph (CXR) plays an important role in both diagnosis and management. CXR is a WHO-recommended tool for TB screening [2]. Thailand has a high TB burden, with a prevalence of 242 cases per 100,000 adults CXR, and is committed to eradication in line with WHO's End TB Strategy, which sets a target of reducing incidence to 89 per 100,000 population by 2027 [3]. In 2019, based on a survey in 360 out of 1,554 hospitals in Thailand, performed by The Royal College of Radiologists of Thailand (RCRT.) and the

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Department of Medical Sciences, Ministry of Public Health (MOPH.), it was estimated that almost half of working hours of radiologists were spent interpreting radiographs. The data collected during 2015-2021 from Songklanagarind Hospital, Prince of Songkla University, in southern Thailand showed that fewer than 25% of chest radiographs were interpreted by radiologists, more than half of which were normal (Table 1).

Table 1. *The number of chest radiographs performed and interpreted in Songklanagarind Hospital in southern Thailand during 2015-2021.*

Year	Total Number of Chest Radiographs	Chest Radiographs without Radiological Reports	Chest Radiographs with Radiological Reports	Chest Radiographs with Negative Radiological Reports
2015	160,712	141,274 (87.9%)	19,438 (12.1%)	11,696 (60.2%)
2016	146,555	126,902 (86.6%)	19,653 (13.4%)	10,627 (54.1%)
2017	118,828	100,324 (84.4%)	18,504 (15.6%)	10,538 (56.9%)
2018	98,514	77,326 (78.5%)	21,188 (21.5%)	12,737 (60.1%)
2019	98,412	76,603 (77.8%)	21,809 (22.2%)	13,853 (63.5%)
2020	89,850	69,241 (77.1%)	20,609 (22.9%)	13,398 (65.0%)
2021	81,382	61,354 (75.4%)	20,028 (24.6%)	13,131 (65.6%)

AI- based CAD software has shown promising accuracy in TB screening [4,5] and the WHO recommended the use of CAD software for TB screening and triage in 2021 [6]. A shortage of radiologists and a high TB burden in Thailand make AI attractive in the market. Private hospitals adopted commercially available AIs to assist radiologists to minimize the risk of missed detection. Some health institutes are developing their own AI systems, hoping that all CXRs will be accurately interpreted or appropriately prioritized. MOPH aims to eliminate TB and improve people's health by integrating AI in the service flow.

Introduction of AI during COVID-19 pandemics

In January 2020, the first case of COVID-19 outside China was reported in Thailand just a few weeks after an outbreak in Hubei, China when millions of Chinese people traveled not only across China but throughout Asia during the Lunar New Year holiday [6]. Because pneumonia is the main manifestation, chest radiographs, initially not recommended to detect or confirm the COVID-19 pneumonia by various organizations [7], played a pivotal role in prioritizing the infected patients to limited healthcare after the third wave of COVID-19 attacked Thailand in the middle of 2021 when the state of emergency was declared and infected patients needed to be admitted to hospitals, field hospitals, and community isolations centers, and finally isolate at home when new cases exceeded 20,000 cases a day [8]. Radiographic units were installed at all field hospitals and some community isolation sites and reports from radiologists were used for triaging the level of medical care. RCRT launched a project called "RadioVolunteer" to interpret and report CXRs of COVID-19 patients in prisons, field hospitals where there was a shortage of radiologists, and some community isolation centers [9]. The RadioVolunteer digital platform was designed to facilitate seamless collaborations between radiologists and healthcare providers. Built on a secure, cloud-based infrastructure, the platform served as the backbone of the RadioVolunteer project and enabled real-time sharing and interpretation of CXRs. Due to the high volume of images and the fact that volunteers ranged from general radiologists to specialists in chest and other organs, the AI-assisted prioritizing system identified and scored the positive radiographs (Figure 1). Cases that seemed to have high abnormality scores were alerted and prioritized in the radiologist worklist. The chest-expert radiologists could quickly review these likely positive cases in real-time as well as quickly screen through likely negative cases later. The general radiologists or subspecialist radiologists in other organ systems felt more comfortable and confident to report the images with low abnormality scores. The volunteers interpreted the original CXR image side-by-side with a computer-assisted image assessed by an AI provided by the platform. During the project, from 31 May 2021 to 25 December 2021, 288,824 CXRs from 115 caring units were interpreted and AI was utilized by more than 350 radiologist volunteers.

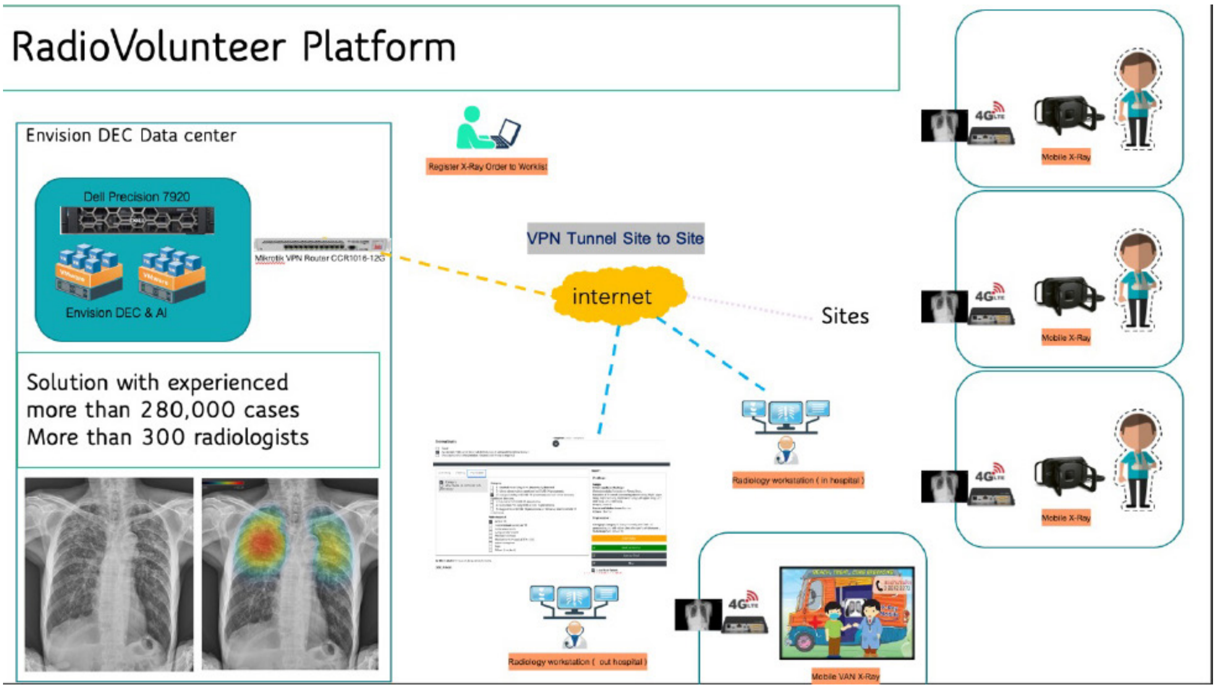

Figure 1. *An infographic showcasing that AI system was introduced in RadioVolunteer platform to identify and score the positive radiographs.*

Development of external validation

While AI models are rapidly entering Thai markets, studies show that many AI models perform worse on external datasets compared to manufacturers' internal data, with only 6% of AI models in medical imaging being externally validated [10,11]. The lack of robust external datasets for validation limits their wider use. While microbiological references are typically recommended for assessing accuracy, comparing AI models with human-read CXRs is crucial when considering their adoption [12].

In Thailand's efforts to integrate artificial intelligence into chest radiograph interpretation, the Thailand Center of Excellence for Life Sciences (TCELS) serves as a crucial national facilitator and coordinator rather than a direct developer of AI algorithms. Operating as a public entity under the Ministry of Higher Education, Science, Research and Innovation, TCELS's primary mandate is to accelerate healthcare innovation by building networks, providing funding, and sharing resources across public and private sector organizations. It acts as a central hub, connecting the different parts of the complex AI ecosystem to ensure cohesive and rapid progress.

TCELS fulfills its mission through several key actions. It provides essential financial support for AI development projects, such as the collaboration to create an AI-based screening tool for pneumonia. A significant part of its role involves fostering strategic public-private partnerships, a prime example being its work within the Yothi Medical Innovation District (YMID) to unite hospitals and technology firms during the COVID-19 pandemic. Furthermore, TCELS works closely with professional bodies, having signed a formal Memorandum of Understanding (MOU) with the RCRT to facilitate resource exchange and co-organize initiatives like the "Standard Dataset for Chest AI" project [13]. Through these efforts, TCELS effectively bridges the gap between research, clinical needs, and commercial application, accelerating the deployment of vital AI health technologies across the nation.

Among radiologists, B Readers-the certified physicians by the NIOSH to diagnose pneumoconiosis-are considered skilled in interpreting CXRs with greater concordance with the final diagnosis of pneumoconiosis compared to other readers [14]. TB share many common radiographic findings with silicosis, the RCRT hypothesized that B Readers would also exhibit proficiency in diagnosing TB on CXR. The 1,097 CXRs, both normal and biologically confirmed TB, carefully curated from various geographic locations in Thailand were interpreted by six B readers. These CXRs were not used for AI training but served as an external test set to conduct external validation.

In 2020, the RCRT, with support from TCELS, launched a vendor-neutral external validation to close the existing gap between internal and real-world performance in Thai population. Vendors submitted results from locked models at predetermined operating points. The protocol included ROC/AUC, sensitivity, specificity, and calibration curves. Results including Thai benchmark performance and recommended thresholds for triage and TB screening, aligned with WHO use cases, were packaged as concise validation documents for hospital adoption and announced on the the RCRT website [15] (Figure 2).

Figure 2. *RCRT webpage where certifications and validation documents of AI submitted for external validation appear and can be acquired [15].*

Thailand healthcare system

There are two important stakeholders in the Thai healthcare system: MOPH, an entity responsible for public hospital covering more than 70% of the hospitals in Thailand and the National Health Security Office (NHSO) that is responsible for the reimbursement model for Universal Health Coverage program, the largest health reimbursement scheme in Thailand.

Giving the growing recognition of the benefit of AI in medicine, AI Clinical Decision Support started to gain traction among several government bodies. Several AI proof of concept were co-developed between the university and MOPH. For example, the R3D3 was co-developed with the Naresuan University and the MOPH hospital, Chattrakan hospital. However, large scale implementation was limited due to the digital infrastructure constraints and policy commitment [16].

During the COVID-19 pandemic, several investments were made to develop a digital platform, digital transformation, and infrastructure to accommodate telemedicine and COVID-19 Certificate to revive Thailand's tourism and economy that was impacted by the COVID-19 lockdown and travel restriction.

The MOPH saw the opportunity and established the Bureau of Digital Health (BDH) in 2022 at the MOPH to continue the digital transformation into the post-COVID-19 era. The office directly reports to the MOPH Chief Information Office (CIO) as a digital transformation office.

The BDH leveraged the national platform originally developed for the COVID-19 vaccination registry to establish the National Digital Health Plat form (NDHP) to support MOPH's hospital digital health initiatives, including online appointments booking, Personal Health Records, and Clinical Decision Support services. By connecting all MOPH hospitals nationwide, the NDHP is able to significantly expand the hospital capabilities by connecting the authorized third-party to develop modules which will become available for all MOPH hospitals. In other words, the NDHP module function helps expand MOPH hospital digital functionality.

The Imaging Hub program was initiated in 2024 as part of the NDHP to act as MOPH radiology image repository for research and patient care. The program offers MOPH in-house developed AI CXR screening available for MOPH hospital free of charge and more AI models are being developed. The Imaging Hub program facilitates the use of AI among the MOPH. hospitals regardless of their size or location [17].

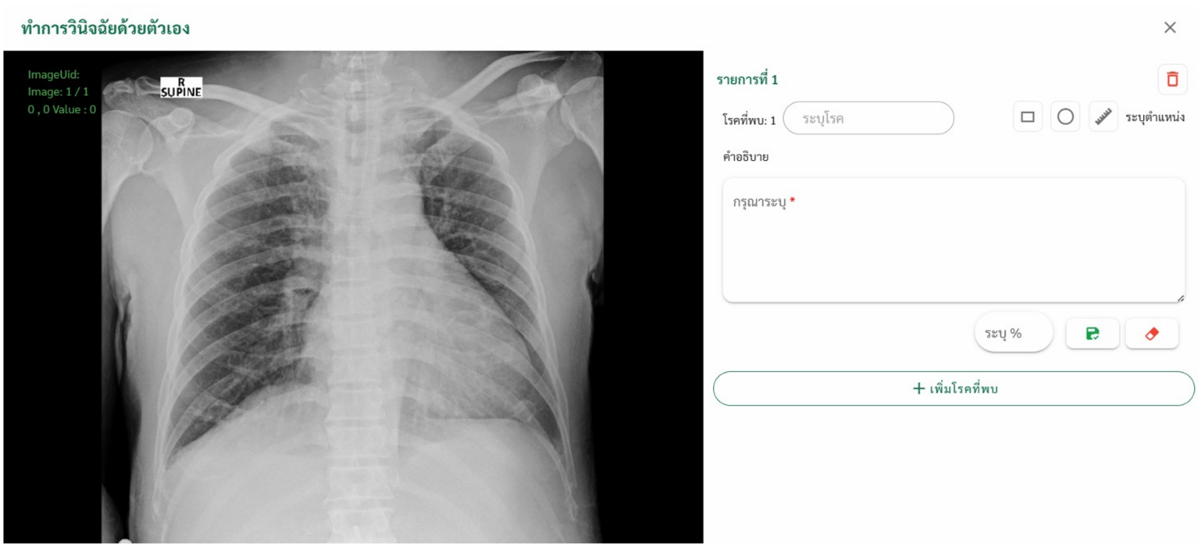

Figure 3. *Imaging Hub panel; the image shows a Chest-X-Ray from MOPH hospitals, stored on Cloud and a panel for physicians to record their findings [16].*

The MOPH also has the AI approval pathway, “Software as a Medical Device (SaMD)” Pathway for healthcare AI under the Medical Device Control Division, Food and Drug Administration (FDA). AI vendor will need approval from this pathway to be certified in Thailand [18].

On the reimbursement side, NHSO is also working with the MOPH to initiate the reimbursement model which will greatly incentivize the AI adoption in Thailand. The NHSO approved AI CXR as a new Universal Coverage Scheme (UCS) health benefit on July 7, 2025 [19]. Approximately 167 MOPH hospitals are eligible for this benefit in 2025. The estimated cost for AI CXR is 329,000 baht per hospital, totaling a budget of 55 million baht in 2025 (Figure 4).

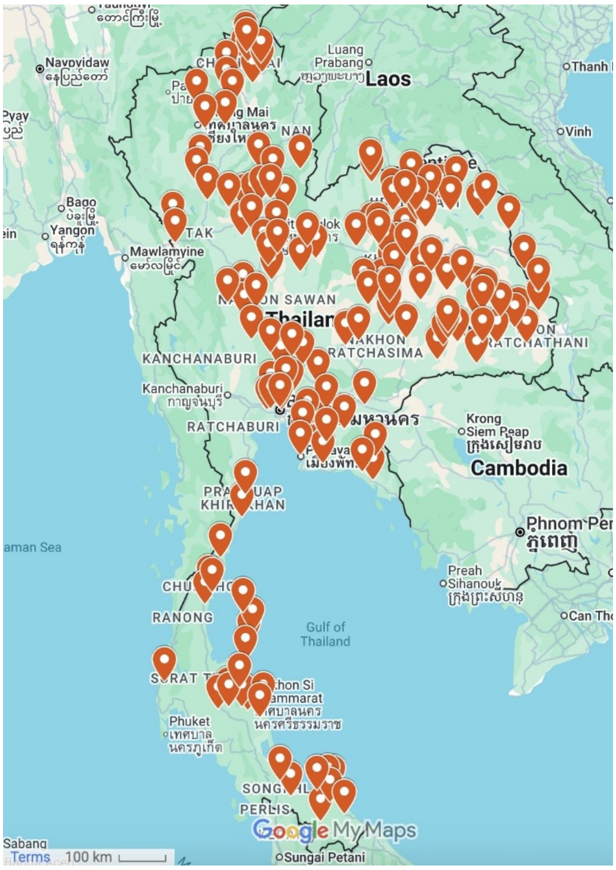

Figure 4. *The map of Thailand showing 167 MOPH hospitals in which AI-assisted workflow for interpreting chest radiographs will be installed by the end of 2025.*

Monitoring (TCELS dashboard)

To ensure the safe and effective nationwide deployment of artificial intelligence in chest radiography, the TCELS and the NHSO established a partnership. A key outcome of this collaboration is the formation of an expert monitoring team tasked with overseeing the real-world application and performance of AI tools. This initiative is critical for building trust among clinicians and ensuring that these advanced technologies consistently enhance patient care and safety in diverse clinical settings. The team's primary objective is to create and implement a robust governance structure for the evaluation, use, and continuous monitoring of AI algorithms in practice.

At the core of this oversight is a proposed framework for the annual review of all hospitals that have integrated chest AI into their diagnostic workflows. This comprehensive evaluation is structured around four key pillars to provide a holistic assessment of the technology's impact. First, ethical and legal considerations examines adherence to data privacy standards, patient consent protocols, and the complex issue of medicolegal liability in cases of AI-assisted diagnostic errors. The framework ensures that the use of AI respects patient rights and that clear lines of accountability are established. Second, technical performance involves the continuous monitoring of the AI algorithm's diagnostic accuracy and reliability. It includes proactive surveillance for issues like "model drift," where an AI's performance degrades over time as it encounters new types of data from different patient populations or imaging equipment. This ensures the tool remains effective long after its initial deployment. Third, workflow Integration assesses how seamlessly the AI tool integrates into existing hospital information systems (HIS) and picture archiving and communication systems (PACS). The goal is to confirm that the AI optimizes the clinical workflow, for example, by automating the triage of urgent cases—rather than creating bottlenecks or increasing the burden on medical staff. Last but not least, user satisfaction gauges the experience and confidence among the clinicians using the AI. Given that user reluctance can be a major barrier to adoption, this feedback is crucial for understanding the practical value of the AI, addressing any usability issues, and ensuring the technology serves as a trusted "second reader" for physicians.

This monitoring framework is designed to be applied to all AI platforms in use, with mainstream commercial systems like Perceptra's Inspectra CXR [20] serving as a key example. Perceptra already provides comprehensive end-to-end support, including extensive monitoring services, which aligns with the national oversight goals (Table 2). This multi-layered approach, combining government oversight, professional self-regulation, and responsible vendor practices, is essential for building a sustainable and trustworthy AI-powered healthcare ecosystem.

Education and Training	Monitoring and Evaluation			
	Dashboard monitoring	Infrastructure Evaluation	Clinical Evaluation	
มหาวิทยาลัยมหิดล คณะแพทยศาสตร์ศิริราชพยาบาล	PERCEPTRA	มูลนิธิ HPP Thailand		มหาวิทยาลัยมหิดล คณะแพทยศาสตร์ศิริราชพยาบาล
• Educational Program (Workshop in regional public hospitals) • Online Training (Basics of AI, Social & Ethical issues, Workflow consideration, Practice based learning & improvement in use of AI)	• Monitor the number of service units, patients, and Images screened • Monitor results from AI-based screening of 8 conditions • Divided into three tiers: NHSO headquarters, NHSO regional offices, and health service units	• Document Policy formulation & Policy implementation • Measure user satisfaction, technology acceptance among healthcare professionals, procurement processes, distribution and implementation, and product improvement • Recommend policies to the NHSO	• Performance report (sensitivity, specificity and Area Under the ROC curve (AUROC) of AI CXR • Optimal threshold value of AI CXR for hospitals of different sizes • Cost analysis of providing Tuberculosis screening using AI CXR compared with conventional screening methods, from the perspective of healthcare providers	• Performance report (sensitivity, specificity and Area Under the ROC curve (AUROC) of AI CXR • Optimal threshold value of AI CXR for hospitals of different sizes. • Cost analysis of providing CA lung screening using AI CXR compared with conventional screening methods, from the perspective of healthcare providers
Support policy roll out and appropriate use of AI-CXR	Monitoring by NHSO	Evaluate the AI CXR implementation a		

Table 2. *The pre-deployment education and the monitor during deployment of AI in chest radiography developed by TCELS, NHSO and non-profit professional organizations; Perceptra provided the dashboard for monitoring.*

Conclusion

Implementing artificial intelligence to assist in interpreting chest radiographs in public health of Thailand requires comprehensive collaboration of government, non-profit professional organizations, and private sectors. A holistic approach, encompassing before and during the deployment, was planned to ensure safety and effectiveness. The outcomes and cost analysis after implementation will be evaluated in 2026.

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Memorial

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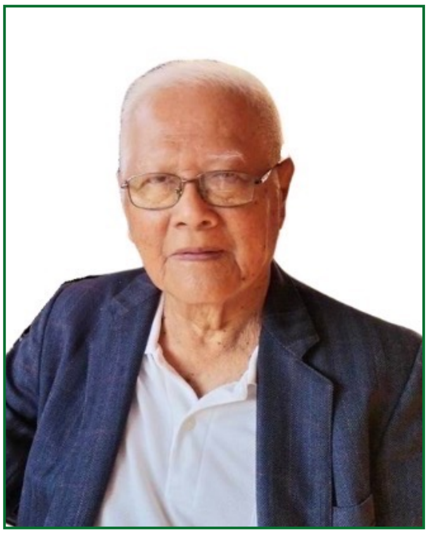

Associate Professor Chongdee Sukthomya, 1936-2025

On April 30, 2025, Associate Professor Chongdee Sukthomya, the first radiologist of Southern Thailand, passed away at the age of 89 years He was born in Bangkok on August 10, 1936, graduated from Faculty of Medicine, Siriraj Hospital in Bangkok in 1960, and qualified by the American Board of Radiology on June 9, 1967.

The Founder of Radiology in Southern Thailand

In the annals of medicine and public health in Southern Thailand, Associate Professor Chongdee Sukthomya, M.D., stands as a figure of paramount importance. A true pioneer, he was not only the founding Head of the Department of Radiology at the Faculty of Medicine, Prince of Songkla University, but is also rightfully venerated as the very first radiologist in the southern region of the nation. His contributions ushered in a new era of radiology in Southern Thailand, leaving an indelible legacy that continues to benefit countless lives.

The Arrival of the Pioneer

The year 1975 marked a critical juncture for radiological sciences in Southern Thailand. The region, which was considered remote in terms of medical advancement, lacked specialized radiological services. Even in the most modern hospitals of the time, such as Hat Yai Hospital and Songkhla Hospital, radiologists were lacking. The crucial task of interpreting radiographic images fell to the attending physicians, a practice that starkly highlighted the disparity in public health services compared to other regions of the country.

This landscape began to transform when Professor Kasem Limwongse, M.D., the visionary first Dean of the Faculty of Medicine, Prince of Songkla University, recognized the urgent need for specialized radiological expertise. In a pivotal move, he initiated the transfer of Dr. Sukthomya from the Faculty of Medicine at Chiang Mai University—a center of advanced medical practice at the time—to undertake the monumental task of establishing the Department of Radiology in the peninsular south.

A Legacy of Foundational Leadership

Occupying the position of the first Head of the Department of Radiology from December 1974 to November 30, 1984, Dr. Sukthomya dedicated a decade to meticulously building the department from the ground up. At that time, Songkla-nagarind Hospital had almost no equipment. The first fluoroscopy machine was introduced in 1977. The hospital began using cobalt radiotherapy and ultrasound imaging and performed the first angiography in Southern Thailand in 1982. It is evident that this was truly a beginning from nothing. His vision and initiative were the driving forces behind nearly all of the department's foundational achievements. His leadership was instrumental in laying the groundwork for the field of medicine that was previously nonexistent in this region.

Songklanagarind Hospital in its early years after construction.

Dr. Chongdee and Dr. Vimol Sukthomya, with the staff, in front of the first CT scanner room in Songklanagarind Hospital.

Beyond his departmental duties, Dr. Sukthomya also served as the Vice Dean during the faculty's formative years. This role placed him in the part of the faculty's administration and strategic development. Consequently, Dr. Sukthomya was also one of the important people shaping the very character and trajectory of the Faculty of Medicine.

His name is a constant presence in the commemorative publications of the Faculty of Medicine, frequently referenced by various departments as a figure of inspiration and foundational importance. This recurring acknowledgment is a clear indicator of the dedication, perseverance, and profound positive influence he bestowed upon the Faculty of Medicine, Prince of Songkla University, and the entire public health system of Southern Thailand—a legacy that endures to this day.

An Enduring Impact

Even after his departure from Prince of Songkla University, Dr. Sukthomya continued to serve the public with unwavering dedication. He chose to join Lampang Cancer Hospital in the Northern Thailand which lacked a radiologist on staff. There, he contributed his expertise in both diagnostic and therapeutic radiology, while also fostering academic growth within the institution.

Dr. Sukthomya came back to visit the Department of Radiology at Songklanagarind Hospital after relocating to work at Lampang Cancer Hospital.

One of his notable initiatives was organizing weekly academic seminars every Thursday afternoon. These sessions brought together multidisciplinary teams including doctors, nurses, radiologic technologists, and staff from various departments to discuss real patient cases and shar knowledge. This collaborative and educational environment not only enhanced patient care but also strengthened interprofessional learning and camaraderie.

The first cohort of radiologic technology students in Southern Thailand.

He remains one of Thailand's most esteemed radiologists whose contributions have left an enduring impact on medical practice, education, and patient care across generations.

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Suthinee Teerajaruwat, M.D.
Department of Radiology, Faculty of Medicine,
Prince of Songkla University.

Wiwatana Tanomkiat, M.D.
Head, Thoracic Imaging, Department of Radiology, Faculty of Medicine,
Prince of Songkla University,
President, Radiological Society of Thailand (RST),
Immediate Past President, The Royal College of Radiologists of Thailand (RCRT).

Keerati Hongsakul, M.D.
Director, Minimally Invasive Cardiovascular and Interventional Radiology (MiSIR),
Facutly of Medicine, Prince of Songkla University,
President, Thai Society of Vascular and Interventional Radiology (TSVIR).

Pramot Tanutit, M.D.
Chair, Department of Radiology, Faculty of Medicine,
Prince of Songkla University,
President, Thai Musculoskeletal Imaging Group (TMIG).

Kittipong Riabroi, M.D., M.Sc.
Dean, Faculty of Medicine, Prince of Songkla University,
Immediate Past President,
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