MALAYSIA STROKE COUNCIL

MINISTRY OF HEALTH MALAYSIA

NNeuR
NATIONAL NEUROLOGY REGISTRY

MALAYSIA NATIONAL STROKE REGISTRY REPORT 2017-2024

CONTRIBUTORS:

NSR TASK FORCE AND STEERING COMMITTEE

EDITED BY:

NORSIMA NAZIFAH S, FIRDAUS AH, NORAINI S,
RABI'ATUL 'ADAWIYAH AR, KHAIRUL AZMI I

Malaysia National Stroke Registry 2017-2024

Edited by:

Norsima Nazifah Sidek
Firdaus Abdul Hamid
Noraini Seman
Rabi'atul 'Adawiyah Abdul Rohim
Khairul Azmi Ibrahim

Published by:

Clinical Research Centre,
Hospital Sultanah Nur Zahirah.

eISBN 978-629-94884-1-5

9 786299 488415

Published by:
Clinical Research Centre,
Hospital Sultanah Nur Zahirah,
Jalan Sultan Mahmud,
20400 Kuala Terengganu,
Terengganu, MALAYSIA.

General Line: +60 9-621 2159
Email: nationalstrokeregistry.nneur@gmail.com
Website: https://www.acrm.org.my/nneur

Disclaimer:
Data reported were supplied by the National Stroke Registry.

Interpretation and reporting are the responsibility of the editors and do not represent the official policy of the publisher or the authors' affiliated institutions. The data presented are absolute numbers rather than rates and are based on reports from participating centres, which may not reflect the actual case numbers in Malaysia. Caution is therefore warranted in drawing conclusions, as the registry is dynamic and figures may differ between this report and real-time data due to ongoing updates. Any errors are the sole responsibility of the authors and editors.

Suggested citation:
National Stroke Registry Malaysia. (2026). Malaysia National Stroke Registry Report 2017–2024. Ministry of Health Malaysia.

The electronic version of this report can be downloaded at https://www.acrm.org.my/nneur

ACKNOWLEDGEMENTS

The National Stroke Registry would like to give its grateful appreciation to everyone who has helped make this report possible.

We would especially like to thank you for the following:

Our source data providers for their hard work and timely data collection and submission.

East Coast Region

Hospital Sultanah Nur Zahirah, Terengganu

Hospital Raja Perempuan Zainab 2, Kelantan

Northern Region

Hospital Seberang Jaya, Pulau Pinang

Hospital Pulau Pinang, Pulau Pinang

Hospital Kepala Batas, Pulau Pinang

Hospital Raja Permaisuri Bainun, Perak

Hospital Taiping, Perak

Hospital Tuanku Fauziah, Perlis

Hospital Sultanah Bahiyah, Kedah

Southern Region

Hospital Sultanah Aminah, Johor

Hospital Melaka, Melaka

Central Region

Hospital Sultan Abdul Aziz Shah, Universiti Putra Malaysia, Selangor

Hospital Tengku Ampuan Rahimah, Selangor

EAST MALAYSIA

Sarawak

Hospital Umum Sarawak

Hospital Bintulu

Hospital Miri

Hospital Sarikei

Hospital Sri Aman

Sabah

Hospital Queen Elizabeth I

Hospital Queen Elizabeth II

- ✓ Institute for Clinical Research, NIH Setia Alam, for its continuous guidance, technical assistance, and unwavering support.
- ✓ Pusat Informatik Kesihatan, Ministry of Health, Malaysia, for managing and funding of this registry (2017-2023)
- ✓ Director-General of Health, Ministry of Health Malaysia, for support for the registry and approval to publish this report
- ✓ All NSR committee members for their dedicated efforts to the registry.
- ✓ Malaysian Stroke Council for sponsorship support for the registry (2024)

TABLE OF CONTENTS

FOREWORD

It is my great pleasure to present the National Stroke Registry Report 2017–2024. This publication marks another significant milestone in our ongoing efforts to enhance stroke care in Malaysia. Since its establishment in 2009, the National Stroke Registry (NSR) has played a vital role in monitoring stroke trends, management practices, and patient outcomes nationwide. The data collected serves as a foundation for evidence-based policies, clinical improvements, and equitable resource planning to strengthen stroke services across the country.

The achievements highlighted in this report reflect the dedication and collaboration of healthcare professionals, researchers, and policymakers committed to advancing stroke prevention, treatment, and rehabilitation. I would like to express my sincere appreciation to all participating hospitals, registry teams, and the Ministry of Health Malaysia for their unwavering support and contributions.

Moving forward, the NSR will continue to serve as a key platform for quality improvement, digital innovation, and research that guide better stroke care and public health outcomes. I hope this report will inspire continued collective efforts to reduce the burden of stroke and improve the quality of life for all Malaysians.

DR SAPIAH BINTI SAPUAN
Head of Neurology Subspecialty, Ministry of Health, Malaysia

FOREWORD

The National Stroke Registry (NSR) continues to play a vital role in monitoring and understanding the burden of stroke in Malaysia. Since its initiation in 2009, the registry has grown steadily and remains an important platform for consolidating and analysing national stroke data.

From 2017 to 2024, a total of 11,413 stroke cases has been reported by participating centres nationwide. This ongoing effort provides valuable insights into stroke patterns, risk factors, management practices, and patient outcomes across the country.

The findings from this registry not only deepen our understanding of stroke care in Malaysia but also guide strategic planning for prevention, early intervention, and rehabilitation. As stroke remains one of the leading causes of mortality and disability, the continued commitment to data collection and analysis is crucial for improving patient outcomes and shaping effective health policies.

We sincerely thank all source data providers, clinicians, coordinators, and collaborators for their unwavering dedication and contributions throughout these years. Special appreciation is also extended to the Director of the Institute Clinical Research (ICR), the Health Informatics Centre, the Medical Development Division, and the Director General of Health, Malaysia, for continuous support and leadership.

Through strengthened collaboration and active participation from hospitals, universities, and other healthcare institutions, we aim to ensure that the National Stroke Registry truly reflects the landscape of stroke care in Malaysia. We hope this report will lay the groundwork for future research, guide policy improvements, and ultimately contribute to better care and outcomes for our patients.

DR LOOI IRENE
Principal Investigator, National Stroke Registry (NSR)

PREFACE

The National Stroke Registry (NSR) Report 2017–2024 represents a significant milestone in Malaysia's ongoing efforts to strengthen stroke surveillance, improve patient outcomes, and guide evidence-based decision-making in healthcare planning. Covering eight years, this report provides valuable insights into the patterns, management, and outcomes of strokes across participating hospitals in the country. Since its inception in 2009, the National Stroke Registry has played a vital role in collecting and analysing data on stroke care delivery. The continuous commitment of participating clinicians, hospitals, and data management teams has enabled the registry to serve as a reliable source of national data—supporting clinical research, policy development, and quality improvement initiatives.

The findings presented in this report highlight both the progress achieved and the challenges that remain. While advances in acute stroke care, rehabilitation, and multidisciplinary collaboration are commendable, there is still a pressing need to enhance public awareness, early detection, and equitable access to care across all regions. We extend our deepest appreciation to all contributors for their steadfast support and dedication to ensuring the success of the National Stroke Registry. Their collective effort has made it possible to continuously improve stroke care in Malaysia through evidence, collaboration, and innovation.

Last but not least, we hope that this report will continue to serve as a valuable reference for healthcare professionals, researchers, and policymakers in shaping the future of stroke prevention and management in Malaysia.

Editorial Team

MALAYSIA NATIONAL STROKE REGISTRY COMMITTEES (2024-2026)

Governance Board

- Datin Dr Zariah Abdul Aziz, former NSR Principal Investigator
- Prof. Hamidon Basri, Director, Hospital Pengajar UPM
- Dato' Dr Hanip Rafia, former Head of Neurology Service, MOH
- Datin Dr Sheamini Sivasampu, former ICR Director
- Dr Sapiah Sapuan, Head of Neurology Subspecialty, MOH
- Assoc. Prof. Dr Hoo Fan Kee, President of MSC

Steering Committee

- Chairman: Dr Irene Looi
- Co-chairman
    - Dr Law Wan Chung, Neurologist, Hospital Umum Sarawak
    - Dr Khairul Azmi Ibrahim, Neurologist, Hospital Sultanah Nur Zahirah
    - Dr Tan Hui Jieh, Neurologist, Hospital Raja Permaisuri Bainun
    - Assoc. Prof. Dr Abdul Hanif Khan Yusof Khan, UPM
    - Dr Mohamed Azlam Bin Mohamed Micdhadhu, Hospital Seberang Jaya
    - Dr Presaad Pillai A/L Perianen, Neurologist, Hospital Queen Elizabeth II
- Registry manager: Mrs Norsima Nazifah Sidek, CRC Hospital Sultanah Nur Zahirah

Task Force Committee

Neurologist

- Assoc. Prof. Dr Law Zhe Kang, Hospital Canselor Tunku Muhriz
- Dr Tay Jiann Shyang, Hospital Umum Sarawak
- Dr Wong Sing Keat, Pusat Perubatan Pakar Sri Kota
- Dr Wan Asyraf Wan Zaidi, Hospital Canselor Tunku Muhriz
- Dr Koo Kim Lim, Hospital Sungai Buloh
- Dr Chee Yong Chuan, Hospital Pakar Universiti Sains Malaysia
- Dr Naimah Binti Mohd Saleh, Hospital Sultanah Bahiyah
- Dr Rose Izura Binti Abdul Hamid @ Abdul Razak, Hospital Raja Perempuan Zainab 2

Non-Neurologist

- Prof. Dr Kamarul Imran Musa, School of Medical Sciences, Universiti Sains Malaysia (USM), Kampus Kesihatan
- Dr Chin Chen Joo, Medical Officer, CRC Hospital Seberang Jaya
- Dr Amy Hwong Wen Yea, Head of Centre for Clinical Epidemiology, ICR
- Dr Firdaus Abd Hamid, Medical Officer, CRC Hospital Sultanah Nur Zahirah
- Ms Norazida Ab Rahman, Pharmacist, Centre for Clinical Outcomes Research, ICR
- Mr King Teck Long, Pharmacist, Hospital Umum Sarawak
- Mr Loh Hong Chuan, Pharmacist, CRC Hospital Seberang Jaya

IT Team (eNSR): Altus Solutions Sdn. Bhd.

LIST OF INVESTIGATORS AND SITES

Region	Site investigator	Site Data Provider
East Coast Region	Dr Khairul Azmi Ibrahim Datin Dr Zariah Abdul Aziz	Hospital Sultanah Nur Zahirah
	Dr Rose Izura Abd Hamid	Hospital Raja Perempuan Zainab II
Northern Region	Dr Irene Looi	Hospital Seberang Jaya
	Dr Chin Chen Joo	Hospital Kepala Batas
	Dr Hor Jyh Yung	Hospital Pulau Pinang
	Dr Tan Hui Jieh	Hospital Raja Permaisuri Bainun
	Dr Cheah Wee Kooi	Hospital Taiping
	Dr Fatin Arsyida Binti Abd Rashid Dr Radzman Bin Ramli	Hospital Tuanku Fauziah
	Dr Ong Beng Hooi	Hospital Sultanah Bahiyah
Southern Region	Dr Hamdi Najman Bin Achok	Hospital Sultanah Aminah
	Dr Mohd Azman M Aris	Hospital Melaka
Central Region	Assoc. Prof. Dr Abdul Hanif Khan Yusof Khan	Hospital Sultan Abdul Aziz Shah, Universiti Putra Malaysia
	Dr Sapiah Sapuan	Hospital Sungai Buloh
	Dr Raymond Tan Yen Leong	Hospital Tengku Ampuan Rahimah
East Malaysia	Dr Law Wan Chung	Hospital Umum Sarawak Hospital Bintulu Hospital Miri Hospital Sarikei Hospital Sri Aman
	Dr Chia Yuen Kang	Hospital Queen Elizabeth I Hospital Queen Elizabeth II

LIST OF CONTRIBUTORS

Editorial Team Members:

Norsima Nazifah Sidek (Chief Editor)
Deputy Head (Research), Clinical Research Centre, Hospital Sultanah Nur Zahirah

Dr Firdaus Abdul Hamid
Medical Officer, Clinical Research Centre, Hospital Sultanah Nur Zahirah

Dr Rabi'atul 'Adawiyah Abdul Rohim
Research Officer, Clinical Research Centre, Hospital Sultanah Nur Zahirah

Noraini Seman
Nurse, Clinical Research Centre, Hospital Sultanah Nur Zahirah

Introduction

Norazida Ab Rahman
Pharmacist, National Institute of Health (NIH)

Norsima Nazifah Sidek
Deputy Head (Research), Clinical Research Centre (CRC), Hospital Sultanah Nur Zahirah

Chapter 1

Dr Amy Hwong Wen Yea
Head of Centre for Clinical Epidemiology (CCE), National Institute of Health (NIH)

Dr Law Wan Chung
Consultant Neurologist, Sarawak General Hospital

Chapter 2

Assoc. Prof. Dr Wan Asyraf Wan Zaidi
Consultant Neurologist and Clinical Lecturer, Faculty of Medicine, Universiti Kebangsaan Malaysia (UKM)

Dr Tan Hui Jieh
Neurologist, Hospital Raja Permaisuri Bainun

Dr Firdaus Abdul Hamid
Medical Officer, Clinical Research Centre, Hospital Sultanah Nur Zahirah

Chapter 3

Dr Law Wan Chung
Consultant Neurologist, Hospital Umum Sarawak

Assoc. Prof. Dr Abdul Hanif Khan Yusof Khan
Neurologist and Clinical Lecturer, Universiti Putra Malaysia (UPM)

Loh Hong Chuan
Pharmacist, Hospital Seberang Jaya

Chapter 4

Dr Khairul Azmi Ibrahim
Consultant Neurologist, Hospital Sultanah Nur Zahirah

Dr Mohamed Azlam Mohamed Micdhadhu
Neurologist, Hospital Seberang Jaya

Dr Chow Sing Thou
Medical Officer, Hospital Seberang Jaya

Chapter 5

Dr Rose Izura Abd Hamid
Consultant Neurologist, Hospital Raja Perempuan Zainab II

Dr Tay Jiann Shyang
Neurologist, Hospital Umum Sarawak

Dr Tan Rou Yi
Medical Officer, Hospital Seberang Jaya

Review Panel:

Dr Sapiah Sapuan
Head of Neurology Subspecialty, Ministry of Health, Malaysia

Assoc. Prof. Dr Hoo Fan Kee
President of the Malaysia Stroke Council (MSC)

Dr Irene Looi
Principal Investigator, National Stroke Registry (NSR)

Prof. Kamarul Imran Musa
Public Health Physician (Medical Epidemiology & Biostatistics),
Universiti Sains Malaysia (USM) Kubang Kerian

External Review Panel

Dr Saiful Safuan Bin Md Sani
Acute Internal Medicine Specialist
Hospital Ampang
(Head of Internal Medicine Specialty, Ministry of Health)

Dr Ridzuan Bin Dato' Mohd Isa
Emergency Medicine and Trauma Consultant
Hospital Ampang
(Head of Emergency Medicine Speciality, Ministry of Health)

Dr Zulkifli Zaki Abdul Ghani
Consultant Interventional Neuroradiologist
Hospital Sungai Buloh
(Head of Interventional Neurologist, Ministry of Health)

Dr Azmi Bin Alias
Head and Senior Consultant Neurosurgeon,
Department Of Neurosurgery,
Tunku Abdul Rahman Neuroscience Institute,
Hospital Kuala Lumpur.
(Head of Neurosurgery Service, Ministry of Health)

Dr Shahanizan Binti Mohd Zin
Senior Principal Assistant Director (Head of Unit)
Medical Services Unit
Medical Development Division
Ministry of Health, Malaysia

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ACA	Anterior Cerebral Artery
AF	Atrial Fibrillation
ASPECTS	Alberta Stroke Program Early CT Score
BMI	Body Mass Index
BP	Blood Pressure
CDA	Clinical Database Assistant
CDM	Clinical Database Manager
CRC	Clinical Research Centre
CRF	Case Report Form
CT	Computed Tomography
CTA	Computed Tomography Angiography
CTP	Computed Tomography Perfusion
DAPT	Dual Antiplatelets Therapy
DG	Director General of Health, Ministry of Health, Malaysia
DOAC	Direct Oral Anticoagulant
DTN	Door-to-needle Time
DWI	Diffusion-Weighted Imaging
EMS	Emergency Medical Service
FLAIR	Fluid-Attenuated Inversion Recovery
GBD	Global Burden of Disease
GCS	Glasgow Coma Scale
HIV	Human Immunodeficiency Virus
IC	Malaysian National Registration Identity Card
ICA	Internal Carotid Artery
ICAD	Intracranial Atherosclerotic Disease
INR	International Normalised Ratio
IPC	Intermittent Pneumatic Compression Device
IQR	Interquartile Range
IVT	Intravenous thrombolysis
LACI	Lacunar Infarction
LDL	Low-Density Lipoprotein
LMWH	Low-Molecular-Weight Heparin
LVO	Large Vessel Occlusion
MCA	Middle Cerebral Artery
MeVO	Medium Vessel Occlusion

MI	Myocardial Infarction
mmHg	Millimetre Mercury
MOH	Ministry of Health
MRA	Magnetic Resonance Angiography
MRI	Magnetic Resonance Imaging
mRS	Modified Rankin Scale
MT	Mechanical Thrombectomy
NIHSS	National Institutes of Health Stroke Scale
NOAC	Novel Oral Anticoagulant/Non-Vitamin K Antagonist Oral Anticoagulant
NSR	National Stroke Registry
OCSP	Oxfordshire Community Stroke Project
OSA	Obstructive Sleep Apnoea
OT	Occupational Therapy
PACI	Partial Anterior Circulation Infarction
PCA	Posterior Cerebral Artery
POCI	Posterior Circulation Infarction
SAH	Subarachnoid Haemorrhage
SAPT	Single Antiplatelet Therapy
SC	Site Coordinator
SDP	Source Data Provider
SGH	Sarawak General Hospital
TACI	Total Anterior Circulation Infarction
TIA	Transient Ischaemic Attack
TICI	Thrombolysis in Cerebral Infarction
TOAST	Trial of Org 10172 in Acute Stroke Treatment
UFH	Unfractionated Heparin
UGIB	Upper Gastrointestinal Bleeding
VTE	Venous Thromboembolism

INTRODUCTION

Background

The World Health Organization defined stroke as a clinical syndrome marked by a rapid onset of symptoms or signs of focal (and occasionally global) cerebral dysfunction, lasting more than 24 hours or resulting in death, with no apparent cause other than a vascular origin. Stroke is the second-leading cause of death and the third-leading cause of disability among non-communicable diseases worldwide, with a trend of increasing stroke burden (incidence, prevalence, and disability-adjusted life-years lost (DALY)) between 1990 and 2021 *(GBD, 2024).* In Malaysia, stroke (not known if ischaemic or haemorrhagic) is ranked as the sixth most common cause of death, accounting for approximately 2.6% of all deaths in 2024 *(DOSM, 2025).* Notably, there was a rising trend in the incidence of stroke among younger adults, with an increase of 53.3% among men and 50.4% among women aged 35–39 between 2008 and 2016 *(Hwong et al., 2021).*

Despite the significant impact and burden of stroke in Malaysia, comprehensive and real-time national data on stroke incidence, risk profiles, management, and outcomes were scarce until the establishment of the National Stroke Registry (NSR) in 2009. Establishment of the NSR reflects Malaysia's commitment to advancing the quality of stroke care through evidence-based planning. It enables the systematic collection of data related to clinical presentation, treatment, outcomes, and resource utilisation of stroke patients. This centralised repository not only facilitates clinical audits but also allows comparison of local practices with international standards. Furthermore, the registry supports national-level budget planning and resource allocation, strengthens stroke prevention and public education strategies, and serves as a reference for targeted health promotion initiatives. The registry serves not only as a surveillance system, but also as a foundation for continuous quality improvement and stroke research in Malaysia. To date, over twenty publications have been produced using data from NSR, contributing valuable insights into stroke epidemiology, clinical outcomes, and healthcare delivery practices. These publications reflect the growing utility of the registry in informing policy decisions, identifying care gaps, and guiding evidence-based interventions to improve stroke management nationwide.

Objectives

The objectives of the National Stroke Registry are:

1. To describe the demographic pattern of stroke patients.
2. To describe the clinical presentation and distribution of stroke subtypes.
3. To determine the risk factors for stroke.
4. To describe the pharmacological and non-pharmacological management of stroke.
5. To determine the frequency and types of stroke complications.

Design

The NSR is a multicentre, prospective, observational, and hospital-based registry of patients with stroke presented to hospitals in Malaysia. Participating hospitals (clinical sites) consecutively enrol patients with acute stroke who meet eligibility criteria and submit data through the NSR data collection and reporting platform. Patients attend the clinical sites as and when required, as per the standard of care at the site, with a follow-up period of three months. Data are collected as part of the clinical routine and as they become available.

Study Population and Patients' Recruitment

Patients with acute stroke are recruited from participating sites across Malaysia. Participation of clinical sites in the registry is on a voluntary basis. Clinical sites that satisfy the following criteria are invited to participate in the NSR:

1. Clinical sites that provide healthcare services for patients with stroke in Malaysia.
2. Each site shall have a Principal Investigator who is also a licensed physician and a qualified professional with experience in stroke management.
3. Each site must appoint a Site Coordinator (SC). SC is responsible for all aspects of registry management and data collection at the site and liaises with the NSR Manager.
4. Each site shall accept responsibility for data collection and ensure proper record keeping and documentation.
5. Each site shall agree to comply with the registry procedures and be willing to be subjected to ongoing review of data by the NSR. This may include one or more site visits by prior arrangement.

All patients with acute stroke undergoing treatment at participating clinical sites are eligible for entry into the NSR. In addition, a site may opt to submit data of existing stroke patients on follow-up care at the site. Inclusion criteria are as follows:

1. Clinical diagnosis of stroke within 2 weeks of onset.
2. Age 12 years and older.

Patients cannot be withdrawn from the database, nor can participating sites unilaterally terminate a patient's involvement. Any request for data deletion must be submitted with clear justification. The request will be reviewed by the registry manager, who holds the authority to approve and execute the deletion if deemed appropriate.

Data Collection

Each participating clinical site collects information about patients with stroke according to a pre-specified set of variables in the data collection form. A comprehensive data dictionary is available to guide data entry at sites. Trainings are provided regularly to ensure standardised data collection and interpretation.

Outcomes were captured during routine follow-up visits at the outpatient clinics. In addition, data were linked to the National Death Registry database to determine mortality status. The National Registration Department provided access to the death registry through the National Institutes of Health Malaysia.

Analysis

This report covers the period from 2017 to 2024. Descriptive statistics are used to present data using frequency, percentage, mean with standard deviation, and median with interquartile range, as appropriate.

CHAPTER 1: PATIENT PROFILES AND PREHOSPITAL CHARACTERISTICS

- **Younger age at stroke onset:** the mean age of stroke patients was 60.6 years, with nearly half below 60 years and about 13% below 45 years
- **Prehospital and emergency medical services use:** about half of stroke patients arrived by emergency medical services. Many patients continued to rely on private transport.
- **Onset-to-door time and hospital admission:** median onset-to-door time ranged from 8.5 hours in 2017 to 6.3 hours in 2024. Only about one-third of ischaemic stroke patients arrived within the 4.5-hour treatment window. Over 80% were admitted to general wards with standard beds.

Overview

Between 2017 and 2024, data were contributed by 21 source data providers, with the number and type of participating sites varying by year. As participation was voluntary and comprised mostly tertiary hospitals, the data may over represent patients receiving specialized care. Taking these factors into account, data were summarized across the entire 2017–2024 period to provide an overall profile of patients registered. Where relevant, ranges across years are presented to illustrate variability.

There was a total of 11,413 stroke patients who were admitted throughout the eight years, with a total of 11,525 admissions (**Table** 1.1).

The reduction in the number of records observed in 2021 and 2022 does not necessarily indicate a true decline in stroke incidence. Although nationwide lockdown measures were implemented in 2020, data collection during that year remained relatively stable. In contrast, the lower data volume in 2021 and 2022 was largely attributable to system- and operational-level factors, including the transition to a new registry system under the Health Informatics Centre (PIK), which required new user registration, system training, and workflow adaptation at participating sites. In addition, ongoing human resource constraints and the continued prioritisation of COVID-19–related services limited the capacity of sites to consistently collect and enter stroke registry data. These factors likely contributed to the reduced data capture during this period.

Table 1.1: List of Hospital Sites

Name of Source Data Provider	2017		2018		2019		2020		2021		2022		2023		2024		Total	
	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P
Hospital Bintulu	55	55	77	77													132	132
Hospital Kepala Batas	13	13															13	13
Hospital Melaka					9	9					20	20	12	12	14	14	55	55
Hospital Miri	9	9	8	8									9	9			26	26
Hospital Pulau Pinang															119	119	119	119
Hospital Queen Elizabeth I															198	198	198	198
Hospital Queen Elizabeth II															13	13	13	13
Hospital Raja Perempuan Zainab 2	272	270	230	229	298	297	263	260	79	79	82	82	38	38	118	118	1380	1373
Hospital Raja Permaisuri Bainun															131	130	131	130
Hospital Sarikei	45	45	53	53													98	98
Hospital Seberang Jaya															413	408	413	408
Hospital Sri Aman	27	27	30	30													57	57
Hospital Sultan Abdul Aziz Shah															10	10	10	10
Hospital Sultanah Aminah					3	3	185	184	89	89	185	184	269	268	372	371	1103	1099
Hospital Sultanah Bahiyah	18	18	14	14													32	32
Hospital Sultanah Nur Zahirah	893	881	672	668	614	601	304	304	392	389	110	110	365	359	931	916	4281	4228
Hospital Taiping			5	5	6	6											11	11
Hospital Tengku Ampuan Rahimah	3	3	122	120													125	123
Hospital Tuanku Fauziah	71	71	12	12	1	1	2	2			11	11	47	47	44	44	188	188
Hospital Umum Sarawak	524	518	498	492	77	77	373	370	396	393	463	453	401	396	407	400	3139	3099
Others*															1	1	1	1
Total	1930	1910	1721	1708	1008	994	1127	1120	956	950	871	860	1141	1129	2771	2742	11525	11413

**A = No of admission*
**P = No of patients*
**Others = Training site*

Age, Sex, and Ethnicity

Table 1.2 shows that the mean age of stroke patients remained consistent throughout the years, with an overall mean age of 60.6 years (SD: 13.5). This is younger than the global mean age of 64.4 years (95% CI: 62.9, 65.8) reported in a systematic review. The review also noted that patients with strokes in low- and middle-income countries were significantly younger than those in high-income countries (63.1 years vs. 68.6 years, $p < 0.01$) (*Rahbar et al., 2022).* Compared to the previous Malaysian National Stroke Registry report between 2009–2016, where the mean age was 62.5 (SD: 12.6) years, the current data suggest that stroke is potentially occurring at a younger age in the country *(Aziz & Sidek, 2016).*

The largest percentage of patients were aged 60-69 years (27.7%) and followed by 50-59 years (24.7%). Nearly half of the patients were below 60 years of age (45.9%), and 12.7% below 45 years. The percentage of patients with young stroke (<45 years) appeared higher in 2020-2024 (12.0-15.7%) as compared to 2017-2019 (9.5-11.0%). This rise is concerning and may reflect increasing cardiovascular risk factors such as hypertension, diabetes, and dyslipidaemia among younger Malaysians *(Mohd Nor et al., 2022).* Improved diagnosis of stroke in younger individuals may also have contributed to this observation.

Men accounted for approximately 60% of the total stroke patients. The mean age of onset for men was younger (59.6 years; SD:13.2) compared to women (62.1 years; SD: 13.8) (**Table 1.3**). By ethnic groups, 70.3% of patients were Malay. The ethnic distribution slightly differed from that of the Malaysian general population. (*DOSM, 2025),* which likely reflects the regional variation of the participating hospitals. (**Table 1.2** and **Table 1.3**).

Table 1.2: Sociodemographic Characteristics of Patients

Demographic characteristics	2017 (N=1910)	2018 (N=1708)	2019 (N=994)	2020 (N=1120)	2021 (N=950)	2022 (N=860)	2023 (N=1129)	2024 (N=2742)	Total (N=11413)
Age in years, mean (SD)	61.9 (13.2)	61.8 (13.3)	61.5 (13.3)	60.2 (12.8)	60.7 (13)	59.7 (13.5)	60 (13.9)	59.4 (14.1)	60.6 (13.5)
Age groups, n (%)									
<20	3 (0.2)	3 (0.2)	6 (0.6)	0 (0.0)	2 (0.2)	0 (0.0)	5 (0.5)	25 (0.9)	44 (0.4)
20-29	19 (1.0)	20 (1.2)	5 (0.5)	6 (0.5)	10 (1.1)	8 (0.9)	10 (0.9)	21 (0.8)	99 (0.9)
30-39	85 (4.5)	75 (4.5)	35 (3.5)	62 (5.6)	41 (4.4)	56 (6.6)	66 (6.0)	170 (6.2)	590 (5.2)
40-49	253 (13.3)	218 (13.0)	125 (12.6)	171 (15.5)	138 (14.7)	146 (17.3)	179 (16.2)	431 (15.7)	1661 (14.7)
50-59	458 (24.2)	404 (24.1)	266 (26.8)	288 (26.1)	245 (26.0)	200 (23.7)	269 (24.3)	658 (24.0)	2788 (24.7)
60-69	515 (27.2)	464 (27.7)	282 (28.4)	313 (28.4)	271 (28.8)	231 (27.3)	285 (25.7)	772 (28.2)	3133 (27.7)
70-79	429 (22.6)	366 (21.8)	202 (20.4)	207 (18.8)	170 (18.1)	158 (18.7)	222 (20.1)	491 (17.9)	2245 (19.9)
>=80	134 (7.1)	127 (7.6)	71 (7.2)	55 (5.0)	64 (6.8)	46 (5.4)	71 (6.4)	173 (6.3)	741 (6.6)
Sex, n (%)									
Men	1126 (59.0)	995 (58.3)	576 (57.9)	732 (65.4)	554 (58.3)	561 (65.2)	669 (59.3)	1622 (59.2)	6835 (59.9)
Women	784 (41.0)	713 (41.7)	418 (42.1)	388 (34.6)	396 (41.7)	299 (34.8)	460 (40.7)	1120 (40.8)	4578 (40.1)
Ethnic groups, n (%)									
Malay	1400 (74.0)	1187 (70.3)	896 (92.4)	744 (68.4)	636 (68.2)	501 (58.7)	760 (68.5)	1789 (65.6)	7913 (70.3)
Chinese	208 (11.0)	203 (12.0)	38 (3.9)	161 (14.8)	137 (14.7)	164 (19.2)	177 (16.0)	412 (15.1)	1500 (13.3)
Indian	6 (0.3)	40 (2.4)	2 (0.2)	21 (1.9)	16 (1.7)	27 (3.2)	34 (3.1)	148 (5.4)	294 (2.6)
Others	261 (13.8)	241 (14.3)	32 (3.3)	152 (14.0)	138 (14.8)	148 (17.3)	120 (10.8)	317 (11.6)	1409 (12.5)
Non-Malaysians	17 (0.9)	17 (1.0)	2 (0.2)	10 (0.9)	5 (0.5)	14 (1.6)	18 (1.6)	61 (2.2)	144 (1.3)

** Missingness range from 0.0%-1.8% for variable age and 0.5%-2.9% for variable ethnic group*

Table 1.3: Age of Patients Based on Sex

	2017 (N=1910)	2018 (N=1708)	2019 (N=994)	2020 (N=1120)	2021 (N=950)	2022 (N=860)	2023 (N=1129)	2024 (N=2742)	Total (N=11413)
Sex	Mean (SD)	Mean (SD)	Mean s(SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean s(SD)	Mean (SD)	Mean (SD)
Men	61.1 (13.1)	60.6 (12.9)	60.2 (13.2)	59.6 (12.5)	59.6 (12.6)	58.5 (12.4)	59.6 (13.6)	58.3 (14)	59.6 (13.2)
Women	63.0 (13.1)	63.4 (13.7)	63.3 (13.2)	61.5 (13.4)	62.3 (13.5)	61.9 (15.1)	60.6 (14.4)	61.0 (14.1)	62.1 (13.8)

**Missingness range from 0.0%-1.8% for variable age*

*Mean age in years

Hospital Arrival and Admission Characteristics

As data on referral sources and inpatient strokes were largely unavailable for other years, **Figure 1.1** presents the distribution of referral sources for the year 2024 only. In 2024, 77.7% of stroke patients arrived at the hospital from home or the scene, while 20.5% were transferred from other hospitals and 1.8% from other stroke treatment centres. Approximately 4% of cases were inpatient strokes (data not shown).

As shown in **Table 1.4**, 52.3% of stroke patients arrived via emergency medical services (EMS), whereas 47.7% used private transportation (own, relative's, or friend's vehicle). Although year-to-year participation varied, there appeared to be a lower percentage of patients using EMS between 2022 and 2024 (41.8–52.5%) compared with the period from 2017 to 2021 (52.3–65.4%). This decline may reflect differences in regional service accessibility and availability of EMS, but it could also potentially suggest that patients or caregivers continue to rely on private transportation because of limited awareness of time-sensitive treatment options for ischaemic stroke or a perceived lack of urgency of stroke symptoms (*Yuan, 2021)* despite the recognized advantages of EMS in reducing prehospital delays *(Asaithambi et al., 2022).*

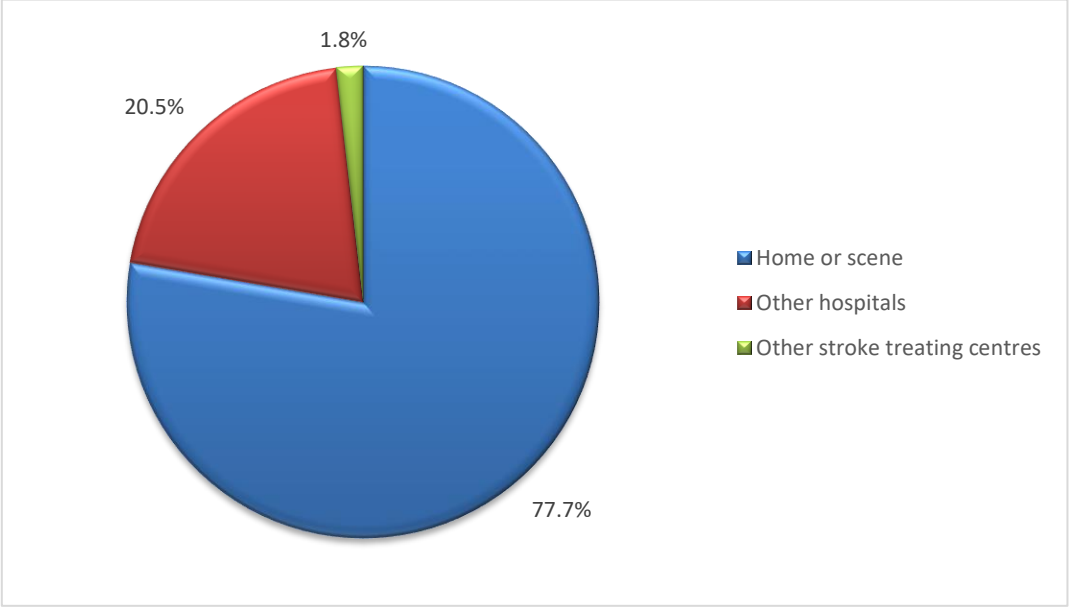


Figure 1.1: Referral Sources for Stroke Patients in 2024

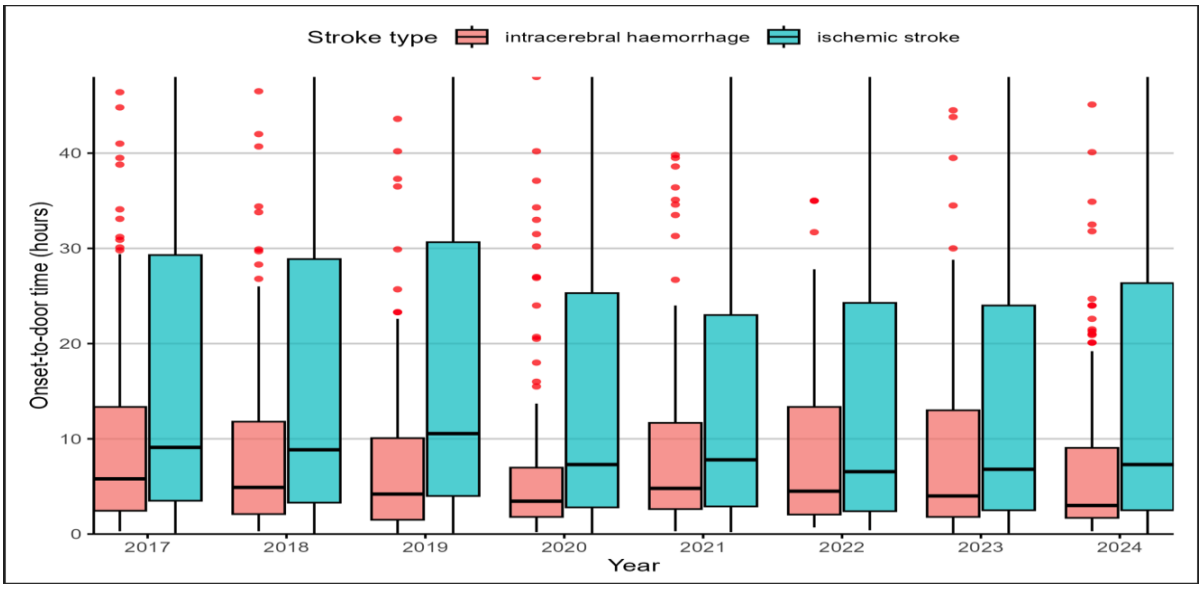
Table 1.4: Hospital Arrival & Admission Characteristics

Hospital arrival & admission characteristics	2017 (N=1930)	2018 (N=1721)	2019 (N=1008)	2020 (N=1127)	2021 (N=956)	2022 (N=871)	2023 (N=1141)	2024 (N=2771)	Total (N=11525)
Mode of arrival, n (%)									
Emergency medical services	998 (54.0)	867 (52.3)	592 (61.7)	538 (58.6)	568 (65.4)	330 (43.5)	553 (52.5)	896 (41.8)	5342 (52.3)
Private transportation	849 (46.0)	791 (47.7)	367 (38.3)	380 (41.4)	301 (34.6)	429 (56.5)	501 (47.5)	1246 (58.2)	4864 (47.7)
Known onset of stroke, n (%)	1927 (99.8)	1691 (98.3)	1000 (99.2)	1109 (98.4)	948 (99.2)	857 (98.4)	1112 (97.8)	2526 (91.7)	11170 (97.1)
Onset-to-door time in hours, median (IQR)									
All stroke types	8.5 (3.2; 26.9)	8.0 (3.0; 24.5)	8.9 (3.5; 26.2)	6.6 (2.6; 22.9)	7.0 (2.9; 19.5)	6.3 (2.4; 23.9)	6.1 (2.4; 22.1)	6.3 (2.3; 22.8)	7.2 (2.7; 24.0)
Ischaemic stroke	9.1 (3.5; 29.3)	8.9 (3.3; 28.9)	10.6 (4.0; 30.6)	7.3 (2.8; 25.3)	7.8 (2.9; 23.0)	6.6 (2.4; 24.3)	6.8 (2.5; 24.0)	7.3 (2.5; 26.4)	8.1 (2.9; 26.8)
Intracerebral haemorrhage	5.8 (2.5; 13.3)	4.9 (2.1; 11.8)	4.2 (1.5; 10.1)	3.5 (1.8; 7.0)	4.8 (2.6; 11.7)	4.5 (2.0; 13.3)	4.0 (1.8; 13.0)	3.0 (1.7; 9.1)	4.3 (2.0; 10.6)
Location of admission, n (%)									
General ward (Standard bed)	1626 (88.7)	1504 (89.4)	955 (97.0)	953 (86.6)	797 (85.3)	720 (84.9)	886 (79.1)	2095 (76.8)	9536 (84.9)
Monitored bed with telemetry	2 (0.1)	5 (0.3)	2 (0.2)	3 (0.3)	1 (0.1)	5 (0.6)	4 (0.4)	35 (1.3)	57 (0.5)
Stroke unit	198 (10.8)	162 (9.6)	27 (2.7)	141 (12.8)	131 (14.0)	115 (13.6)	224 (20.0)	566 (20.7)	1564 (13.9)
Intensive care unit	8 (0.4)	12 (0.7)	1 (0.1)	4 (0.4)	5 (0.5)	8 (0.9)	6 (0.5)	33 (1.2)	77 (0.7)

**Missingness range between 3.7%-22.7% for variable mode of arrival, 0.0%-0.6% for variable known onset of stroke, 0.6%-6.7% for variable onset-to-door time, and 1.5%-5.0% for variable location of admission.*
**Time intervals with negative values or durations exceeding 365 days were assumed to be data entry errors and were treated as missing (NA)*

The majority of patients (97.1%) had a known onset of stroke symptoms. The median onset-to-door time ranged from 8.5 hours (IQR: 3.2; 26.9) in 2017 to 6.3 hours (IQR: 2.3; 22.8) in 2024, with an overall median of 7.2 hours (2.7; 24.0) (**Table 1.4**). Notably, as seen in **Figure 1.2**, ischaemic stroke patients had a longer median onset-to-door time of 8.1 hours (IQR: 2.9; 26.8) as compared to 4.3 hours (IQR: 2.0; 10.6) among those with intracerebral haemorrhage.

The observed reduction in onset-to-door time over the years potentially reflects the improvement of emergency response systems and the expansion of stroke-ready hospitals in Malaysia in recent years *(Chin et al., 2025*). However, this finding should be interpreted with caution as the number and characteristics of contributing hospitals varied across the years, which may influence the apparent trend.



**Time intervals with negative values or durations exceeding 365 days were assumed to be data entry errors and were treated as missing (NA)*

Figure 1.2: Median Onset-to-door Time by Stroke Types from 2017 to 2024

Despite the improvement, the median onset-to-door time remains above the 4.5-hour therapeutic window for intravenous thrombolysis among ischaemic stroke patients. On average, only about one-third (36.3%) of ischaemic stroke patients from our registry reached the hospital within 4.5 hours of symptom onset. Delayed hospital arrival continues to be a major barrier to effective stroke management, often related to poor symptom recognition, cultural beliefs, and transportation challenges to access stroke-ready facilities *(Wiyarta et al., 2025).* Strengthening education to the public, improving prehospital stroke care, and

optimizing inter-hospital referral pathways are essential to reduce prehospital delays and improve access to timely stroke care *(Bosch et al., 2025).*

More than 80% of stroke patients were admitted to general wards with standard beds. In contrast, a smaller percentage were admitted to the stroke unit (13.9%), intensive care units (0.7%), and monitored beds with telemetry (0.5%). The availability of dedicated stroke unit care remains limited, despite evidence supporting its role in improving outcomes among stroke patients *(Chin et al., 2025).*

CHAPTER 2: CLINICAL PRESENTATION AND RISK FACTORS

- **Top 4 Stroke Risk Factors (2017–2024):** Hypertension (70.7%), diabetes mellitus (40.2%), dyslipidaemia (25.2%), and smoking (13.8%) were most common. Hypertension and diabetes have increased over time.
- **Atrial Fibrillation (AF) Trends:** AF prevalence rose to 5.2% (from 3.0%) among ischaemic strokes but remains lower than neighbouring countries. Under-detection due to limited cardiac monitoring is likely.
- **Sex Differences:** Hypertension and diabetes were more frequent in females, while smoking predominated among males.
- **Comorbidity Burden:** Most stroke patients had ≥1 comorbidity. Multimorbidity (≥3 conditions) was more prevalent in ischaemic stroke (30.6%) vs. haemorrhagic stroke (18.8%), reflecting chronic vascular disease patterns.
- **Stroke Subtype Distribution:** Ischaemic strokes comprised 82.9% of all cases. Lacunar infarction (46.5%) was the most frequent OCSP subtype; small vessel occlusion (46.7%) was the leading TOAST aetiology.
- **Neuroimaging Utilization:** While 95% received baseline CT, only 15.6% had CTA and 1.1% had CTP, suggesting limited use of advanced imaging critical for reperfusion decision-making.
- **Initial Presentation & Severity:** Median NIHSS = 5 (IQR 2–11); 15.6% had severe stroke (NIHSS ≥16). Pre-stroke mRS 0 in 77.1% indicated most were functionally independent before stroke onset.

Overview

The four most common risk factors for stroke in our registry from 2017 to 2024 were hypertension (70.7%), diabetes mellitus (40.2%), dyslipidaemia (25.2%), and active smoking (13.8%) (**Table 2.1**). These trends remained relatively stable throughout the period. Compared to data from the previous registry report, which reported hypertension at 67%, diabetes mellitus at 39.6%, dyslipidaemia at 23%, and active smoking at 25.2 %, our findings indicate a noticeable increase in the prevalence of hypertension and diabetes, alongside a decline in smoking rates. Notably, the prevalence of hypertension among our stroke patients

(70.7%) was higher than that reported in Singapore (63.4%) and China (58.5%) *(Venketasubramanian, 2024; Wang et al., 2022*).

Other documented risk factors included prior ischaemic or haemorrhagic stroke, coronary heart disease, atrial fibrillation (AF), congestive heart failure, chronic kidney disease, hormonal contraception, family history of stroke, malignancy, obesity, and obstructive sleep apnoea (OSA).

When comparing stroke subtypes, patients with ischaemic stroke exhibited a higher prevalence of diabetes (42.9% vs. 28.0%), dyslipidaemia (26.7% vs. 16.8%), atrial fibrillation (5.2% vs. 1.6%), smoking (14.3% vs. 10.8%), and other vascular comorbidities such as coronary artery disease and congestive heart failure. In contrast, the prevalence of hypertension and chronic kidney disease was comparable between ischaemic and haemorrhagic stroke patients (**Table 2.2**).

In our registry, atrial fibrillation (AF) was detected in 5.2% of ischaemic stroke patients—an increase from 3.0% in the previous report (*Azi, & Sidek, 2016*). Despite this upward trend, the prevalence remains lower than that reported in neighbouring countries: in Singapore, AF prevalence among stroke patients was reported at 19.2% in *2020 (National Registry of Diseases Office, 2020)*. For Southeast Asia more broadly, systematic reviews showed AF among stroke patients ranged from 2.6% to ~23% *(Pinzon & Karunawan, 2020),* though data are variable and limited. This discrepancy may reflect under-detection or under-reporting, which may be attributed to limited rhythm monitoring and brief inpatient observation periods. Enhanced cardiac surveillance, such as prolonged telemetry or ambulatory monitoring, could improve AF detection and inform more effective secondary stroke prevention strategies.

Analysis of sex differences in vascular risk factors among stroke patients revealed that hypertension was more prevalent in females (74.5%) than in males (68.2%). A similar trend was observed for diabetes mellitus, with higher rates among females (45.2%) compared to males (36.9%) (**Table 2.3**). These findings align with international data, the INTERSTROKE study *(O'Donnell et al., 2016),* which also reported elevated rates of hypertension and diabetes among women with stroke. In contrast, dyslipidaemia prevalence was similar between sexes, while smoking was significantly more common among males (20.4%) than females (3.8%).

Table 2.1: Stroke Risk Factors (2017-2024)

Risk Factors	2024		2023		2022		2021		2020		2019		2018		2017	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
None	325	11.8	144	12.4	117	13.2	127	13.1	141	12.2	127	12.2	198	11.3	199	10.3
Hypertension	1933	70.0	841	72.5	615	69.4	674	69.3	843	72.9	762	73.4	1234	70.5	1348	69.6
Diabetes	1204	43.6	498	42.9	343	38.7	393	40.4	447	38.6	435	41.9	633	36.2	739	38.1
Hyperlipidaemia	898	32.5	356	30.7	254	28.7	247	25.4	292	25.2	215	20.7	319	18.2	351	18.1
Active smoker	360	13.0	123	10.6	127	14.3	128	13.2	162	14.0	111	10.7	281	16.1	313	16.2
Previous TIA/ischaemic stroke	424	15.4	46	4.0	25	2.8	23	2.4	36	3.1	28	2.7	63	3.6	68	3.5
Previous haemorrhagic stroke	15	0.5	69	5.9	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0
Valvular heart disease	31	1.1	6	0.5	1	0.1	4	0.4	2	0.2	2	0.2	2	0.1	7	0.4
Coronary heart disease/previous MI	271	9.8	86	7.4	102	11.5	92	9.5	102	8.8	96	9.2	138	7.9	166	8.6
Atrial fibrillation	137	5.0	69	5.9	53	6.0	48	4.9	53	4.6	21	2.0	78	4.5	81	4.2
Congestive heart failure	63	2.3	11	0.9	3	0.3	5	0.5	8	0.7	0	0.0	8	0.5	5	0.3
Chronic kidney disease	150	5.4	17	1.5	10	1.1	4	0.4	14	1.2	6	0.6	23	1.3	6	0.3
Hormonal contraception	0	0.0	1	0.1	1	0.1	3	0.3	4	0.3	5	0.5	16	0.9	1	0.1
COVID positive in last 6 month	2	0.1	0	0.0	0	0.0	4	0.4	0	0.0	0	0.0	0	0.0	0	0.0
Family history of stroke	3	0.1	5	0.4	6	0.7	8	0.8	16	1.4	25	2.4	31	1.8	76	3.9
HIV	3	0.1	3	0.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Malignancy	14	0.5	3	0.3	1	0.1	4	0.4	4	0.3	0	0.0	5	0.3	3	0.2
Gout	51	1.8	5	0.4	9	1.0	10	1.0	15	1.3	2	0.2	8	0.5	9	0.5
Obesity	13	0.5	0	0.0	3	0.3	2	0.2	2	0.2	2	0.2	18	1.0	1	0.1
Obstructive sleep apnoea	4	0.1	0	0.0	5	0.6	4	0.4	7	0.6	0	0.0	3	0.2	3	0.2

Table 2.2: Stroke Risk Factors Profiles by Type of Stroke

Risk Factors	Ischaemic	Haemorrhagic
	n (%)	n (%)
Hypertension	6937 (71.8)	952 (73.9)
Diabetes	4149 (42.9)	361 (28.0)
Hyperlipidaemia	2578 (26.7)	217 (16.8)
Active smoker	1380 (14.3)	140 (10.9)
Previous TIA/ischaemic stroke	616 (6.4)	65 (5.0)
Previous haemorrhagic stroke	72 (0.7)	10 (0.8)
Valvular heart disease	50 (0.5)	3 (0.2)
Coronary heart disease/previous MI	931 (9.6)	85 (6.6)
Atrial fibrillation	499 (5.2)	21 (1.6)
Congestive heart failure	93 (1.0)	6 (0.5)
Chronic kidney disease	186 (1.9)	33 (2.6)
Hormonal contraception	27 (0.3)	4 (0.3)
COVID positive in last 6 month	5 (0.1)	0 (0.0)
Family history of stroke	139 (1.4)	20 (1.6)
HIV	5 (0.1)	1 (0.1)
Malignancy	30 (0.3)	2 (0.2)
Gout	88 (0.9)	16 (1.2)
Obesity	33 (0.3)	79 (0.5)
Obstructive sleep apnoea	23 (0.2)	3 (0.2)

Table 2.3: Stroke Risk Factors Profiles by Sex and Type of Stroke

Risk Factors, n (%)	Ischaemic Stroke		Haemorrhagic stroke	
	Male	Female	Male	Female
N	5773	3875	756	510
None	618 (10.7)	474 (12.2)	105 (13.9)	84 (16.5)
Hypertension	3971 (68.8)	2950 (76.1)	552 (73.0)	383 (75.1)
Diabetes	2269 (39.3)	1871 (48.3)	198 (26.2)	156 (30.6)
Hyperlipidaemia	1502 (26.0)	1072 (27.7)	125 (16.5)	86 (16.9)
Active smoker	1222 (21.2)	153 (3.9)	122 (16.1)	16 (3.1)

Among ischaemic stroke patients (n = 9,667), the largest proportion had two comorbidities (31.2%), followed by single comorbidity (24.1%) and three comorbidities (21.2%) (**Table 2.4**). Notably, 14.0% of ischaemic stroke patients had no documented comorbidities, while 2.1% had five or more. In contrast, among haemorrhagic stroke patients (n = 1,289), the

most common profile was also only one comorbidity (33.0%), closely followed by two comorbidities (32.1%). A slightly higher percentage of haemorrhagic stroke patients had no comorbidity (16.2%) compared to ischaemic cases. The proportion of patients with three or more comorbidities was lower in the haemorrhagic group, with only 13.6% having three, 4.0% having four, and 1.2% having five or more.

This difference may reflect the distinct pathophysiological mechanisms driving each stroke subtype. Ischaemic strokes are often associated with chronic vascular risk factors such as hypertension, diabetes, and dyslipidaemia, which tend to cluster in older populations with prolonged exposure to systemic disease. In contrast, haemorrhagic strokes may result more acutely from uncontrolled hypertension or vascular anomalies and thus may occur in individuals with fewer accumulated comorbidities (*Hauer et al., 2017).*

The relatively high proportion of patients with no documented comorbidities, especially in the haemorrhagic group (16.2%)—also raises important questions about undiagnosed or underreported risk factors and highlights the need for robust screening and preventive care. These findings underscore the importance of tailoring stroke prevention strategies to the comorbidity burden, with ischaemic stroke patients potentially benefiting from more aggressive risk factor modification and chronic disease management.

Table 2.4: Risk Factors Burden

Variables	Ischaemic		Haemorrhagic	
	n	%	n	%
None	1350	14.0	209	16.2
1 comorbidity	2332	24.1	425	33.0
2 comorbidities	3020	31.2	414	32.1
3 comorbidities	2053	21.2	175	13.6
4 comorbidities	710	7.3	51	4.0
5 or more comorbidities	202	2.1	15	1.2

Stroke Subtypes, OCSP, and TOAST Classifications

Between 2017 and 2024, our registry documented a total of 11525 stroke cases. Of these, ischaemic strokes accounted for the majority, with 9,667 cases (82.9%), followed by intracranial haemorrhages at 1,289 cases (11.1%). Among the haemorrhagic strokes, 23 cases (0.2%) were classified as subarachnoid haemorrhages (SAH). Additionally, there were 503 cases (4.3%) of transient ischaemic attacks (TIA).

Using the Oxfordshire Community Stroke Project (OCSP) classification, ischaemic stroke subtypes were distributed as follows: lacunar infarction (LACI) was the most prevalent, comprising 46.5% (4,270 cases); partial anterior circulation infarction (PACI) accounted for 20.8% (1,958 cases); total anterior circulation infarction (TACI) represented 19.0% (1,780 cases); and posterior circulation infarction (POCI) made up 13.7% (1,282 cases) (**Table 2.5**).

Based on the Trial of Org 10172 in Acute Stroke Treatment (TOAST) etiological classification, small vessel occlusion was the most common mechanism, accounting for 45.7% (4,157 cases) of all ischaemic strokes with documented TOAST classification. This was followed by large artery atherosclerosis at 28.6% (2,543 cases) and cardioembolic at 12.7% (1,133 cases). Strokes attributed to other determined aetiologies were rare, comprising only 0.6% (45 cases), while strokes of undetermined aetiology represented 11.4% (1,014 cases) (**Table 2.6**). Our findings coincided with a study from Asian cohorts such as Korea, Japan and China which reported similar rates of small vessel disease (30–54%), large artery atherosclerosis (25–38%), and cardioembolic proportions (11-22%) *(Kim & Kim, 2014).* However, when compared with international data from major population-based stroke registries, our findings demonstrate a 3 times higher proportion of small vessel disease and a lower proportion of cardioembolic stroke. For instance, based on direct comparison in the North Dublin Population Stroke Study, small vessel disease was reported in 14.4%, large artery atherosclerosis in 8.6%, and cardioembolic in 34.1% of cases *(Marnane, 2010).* Similarly, data from the Erlangen Stroke Project between 1995-2010 reported small vessel proportions of 15–33%, large artery 4–19%, and cardioembolic 17–32% (*Kolominsky-Rabas et al., 2015).*

Overall, the pattern observed in our registry closely mirrors trends reported in other Asian populations, characterized by a higher burden of microvascular pathology and atherosclerosis. This is consistent with the predominance of lacunar infarcts identified through the OCSP classification, reinforcing the notion that small vessel disease remains a major contributor to the stroke burden in our population.

Table 2.5: OCSP Classification of Stroke

OCSP	n	%
TACI	1780	19.0
PACI	1958	20.8
LACI	4370	46.5
POCI	1282	13.7

Table 2.6: TOAST Classification as Aetiology of Stroke

TOAST	n	%
Small vessel	4157	46.7
Large vessel occlusion	2543	28.6
Cardioembolic	1133	12.7
Determined	45	0.6
Undetermined	1014	11.4

Medication before the Event of Stroke (Data from 2024)

In 2024, a total of 2,760 stroke patients were recorded in the registry. Of these, 425 patients (15.4%) were on antiplatelet therapy before admission. The majority were taking aspirin (92.7%), followed by clopidogrel (18.8%), with smaller proportions prescribed ticlopidine, ticagrelor, or dipyridamole. Additionally, 99 patients (3.6%) were receiving anticoagulant therapy at the time of admission. Among them, 30 patients (30.1%) were on warfarin, while 62.6% were treated with direct oral anticoagulants (DOACs). Within the DOAC group, apixaban was the most used (31.3%), followed by dabigatran (20.2%), rivaroxaban (9.1%), and edoxaban (2.0%). Regarding concomitant cardiovascular risk management, 872 patients (31.6%) were on antihypertensive medications, 507 patients (18.4%) were on antidiabetic therapy, and 665 patients (24.1%) were taking lipid-lowering agents (**Table 2.7**).

These findings reveal that while a subset of stroke patients were on preventive pharmacotherapy before admission, the majority of those with baseline vascular risk factors were not receiving any treatment. This gap highlights a critical need to strengthen primary prevention efforts, improve early detection of risk factors, and ensure timely initiation of appropriate therapies. Addressing these shortcomings through better screening, patient education, and healthcare access could significantly reduce stroke incidence and improve long-term cerebrovascular outcomes.

Table 2.7: Patients' Medication Before the Event of Stroke (2024)

Prior Medication	n (%)
None	758 (27.5)
Antiplatelet*	425 (15.4)
Aspirin	314
Cardiprin	80
Clopidogrel	79
Ticlopidine	1
Ticagrelol	1
Dipyridamole	1
Anticoagulant	99 (3.6)
Warfarin	30
Heparin/LMWH	7
Dabigatran	20
Rivaroxaban	9
Apixaban	31
Edoxaban	2
Anti-hypertension	872 (31.6)
Anti-diabetes	507 (18.4)
Lipid-lowering agents	665 (24.1)
Unknown	903 (32.7)

**Any patient may have more than one antiplatelet medication*

Acute Stroke Brain Imaging Findings (Data from 2024)

In 2024, a total of 2,760 stroke patients were recorded in the registry. Of these, 2,631 patients (95.3%) underwent non-contrast CT upon admission; the remainder either underwent magnetic resonance imaging (MRI) brain as the primary modality or the imaging data is missing. Among those imaged, only 430 patients (15.6%) received CT angiography (CTA), 29 patients (1.1%) underwent advanced neuroimaging such as CT perfusion (CTP), 20 patients underwent MRI during their hospital stay. The utilization of CTA and advanced imaging modalities remains very low; ideally, these rates should be higher to enhance diagnostic accuracy and inform timely acute management decisions. From the CTA studies conducted, 108 patients (25%) were identified to have large vessel occlusion (LVO), while 35 patients (8%) demonstrated medium vessel occlusion (MeVO) (**Table 2.8)**. This underscores the clinical importance of vascular imaging in identifying candidates for reperfusion therapy and assisting the acute stroke management.

Regarding ASPECTS (Alberta Stroke Program Early CT Score) documentation, a total of 327 cases were reported in 2024. Among these, 211 patients (64.5%) had an ASPECTS of 7 or higher, indicating relatively preserved brain parenchyma and suitability for reperfusion therapies. In contrast, 53 patients (16.2%) had a score below 3, reflecting extensive early ischaemic changes and limited therapeutic options (**Table 2.9**).

These findings underscore that while baseline neuroimaging is widely implemented, the use of advanced imaging modalities such as CTA, CTP, and MRI remains limited. Expanding access to these techniques could substantially improve diagnostic precision, optimize patient selection for reperfusion therapies, and elevate the overall standard of hyperacute stroke care across the network.

Table 2.8: Characteristics and Findings of Imaging

Type of Brain Imaging	n
Imaging done in another hospital	70
Non-contrast CT	2631
CT Angiography	430
CTA Findings	
Large Vessel Occlusion (LVO)	108
Middle Vessel Occlusion/Distal Vessel Occlusion	35
Vessel occluded	
Left side	54
Right side	53
Bilateral	4
MCA	
M1	52
M2	28
M3	2
M4	1
ACA	
A1	4
A2	2
A3	1
Basilar	
Proximal	1
Mid	0
Distal	4
Vertebral	15
PCA	10
ICA	
Intracranial	19
Extracranial	3
Missing	9
ICAD	29
CT Perfusion	29
MR DWI/ Flair	65
MR Angiography	20
MR Perfusion	5
Non-contrast CT/MRI findings (Side of infarct)	
Left side	154
Right side	161
Bilateral	42
Area of infarct (Irrespective of side)	
Cortical	
MCA	127
ACA	20
PCA	21
Cerebellar	25

Brainstem	
Midbrain	3
Pontine	17
Medulla	1
Subcortical	
Basal Ganglia	84
Internal Capsule	74
Caudate	15
Putamen	9
Globus Pallidum	4
Corona Radiata	40
Centrum Semiovale	12
Presence of old infarct in imaging	
Cortical	287
Brainstem	46
Subcortical (basal ganglia, internal capsule)	407
None	1487

Table 2.9: ASPECT Score of Brain Imaging (n= 327)

ASPECT SCORE	n	%
1	9	2.8%
2	13	4.0%
3	11	3.4%
4	12	3.7%
5	15	4.6%
6	25	7.6%
7	33	10.1%
8	41	12.5%
9	31	9.5%
10	106	32.4%
Not available	1975	
Missing	458	

Event at Emergency Department

Additional initial presentation parameters, including Glasgow Coma Scale (GCS), blood glucose, and LDL cholesterol level are summarized in **Table 2.10** to provide a comprehensive overview of patients' clinical status at presentation. These parameters reflect 2024 data only, as they were newly introduced into the data collection process during this reporting year.

Upon admission to the Emergency Department in 2024, the median systolic blood pressure among patients with ischaemic stroke was 160 mmHg (range: 67–292 mmHg), compared to 182 mmHg (range: 63–278 mmHg) in those with haemorrhagic stroke. Similarly, the median diastolic blood pressure was 88 mmHg (range: 32–187 mmHg) for ischaemic stroke and 100 mmHg (range: 49–182 mmHg) for haemorrhagic stroke (**Table 2.11**).

Analysis of registry data from 2017 to 2024 included 8,532 stroke admissions with documented NIHSS scores. During initial presentation at Emergency Department, the median NIHSS score was 5 (interquartile range [IQR] 2–11). Using standard NIHSS severity bands—mild (0–5), moderate (6–15), moderate–severe (16–20), and severe (21–42)—15.6% of patients presented with moderate–severe or severe strokes (NIHSS ≥16).

The median NIHSS score of 5 (IQR 2–11) in this study is consistent with the American Heart Association's Get With The Guidelines–Stroke (GWTG–Stroke) registry, which reported a similar median score, while the Safe Implementation of Treatments in Stroke study documented a higher median of 11 among ischaemic stroke *admissions (Fonarow et al., 2010; Safe Implementation of Treatments in Stroke, 2017).*These comparisons suggest that stroke severity in our local cohort is consistent with global hospital-based populations, with most patients presenting with mild to moderate deficits, and a substantial 15% had severe stroke requiring advanced hyperacute interventions such as thrombectomy or intensive monitoring.

As per **Table 2.12**, pre-stroke functional status was documented in 1,487 patients. The majority had no pre-existing disability before stroke onset, with 1,146 patients (77.1%) having a pre-stroke modified Rankin Scale (mRS) score of 0, and only 91 patients (6.1%) presenting with moderate to severe disability (mRS 4–5) at baseline. This distribution aligns with findings from the HERMES (pooled thrombectomy trials) substudy, of which analysis of those patients in the RCTs with mild pre-stroke morbidity was done. It was reported that around 60% of patients had a pre-stroke mRS of 0 while 11% of patients had pre-stroke mRS of 1-2 *(McDonough et al., 2023).* The high proportion of patients with pre-stroke mRS 0 in our registry underscores the importance of delivering high-quality stroke care, including

timely access to acute interventions and comprehensive rehabilitation services. Given that this pattern mirrors trends observed in high-income countries, it reinforces the need to maintain and expand stroke care infrastructure to optimize recovery outcomes and reduce long-term disability.

Table 2.10: Clinical Parameters at Initial Presentation

	2024	2023	2022	2021	2020	2019	2018	2017
Glasgow Coma Scale								
n	2626	1137	873	960	1137	1017	1709	NA
Median (IQR)	15 (1)	15 (1)	15 (1)	15 (1)	15 (1)	15 (1)	15 (1)	NA
Missing	0	0	0	13	20	21	41	NA
Systolic blood pressure, mmHg								
n	2661	1160	886	973	1156	1038	1750	1938
Median (IQR)	164 (47)	160 (22)	162 (41)	159 (43)	162 (39)	163 (46)	162 (41)	162 (43)
Missing	24	0	0	0	1	0	0	0
Diastolic blood pressure, mmHg								
n	2611	1160	886	973	1157	1038	1750	1931
Median (IQR)	90 (26)	90 (24)	90 (22)	90 (24)	90 (23)	88 (22)	89 (23)	89 (23)
Missing	74	0	0	0	0	0	0	7
Glucometer, mmol/L								
n	2225	874	711	706	764	776	1436	1406
Median (IQR)	7.8 (4.9)	8.2 (5.4)	8.0 (4.6)	7.4 (4.2)	7.3 (4.2)	7.6 (5)	7.0 (4.1)	7.1 (4.8)
Missing	460	286	175	267	393	262	314	532
LDL cholesterol, mmol/L								
n	1582	680	410	557	529	524	1043	1048
Median (IQR)	3.6 (2.0)	3.3 (1.9)	3.2 (2.0)	3.7 (2.1)	3.8 (2.1)	4.1 (2.0)	3.4 (2.0)	3.6 (2.0)
Missing	1103	480	476	416	0	0	0	7

Table 2.11: Blood Pressure at Initial Presentation Based on Type of Stroke (Ischaemic vs Haemorrhagic)

	Ischaemic	Haemorrhagic
Systolic blood pressure, mmHg		
n	9647	1265
Median (IQR)	160 (41)	182 (48)
Missing	1	1
Diastolic blood pressure, mmHg		
n	9645	1265
Median (IQR)	88 (22)	100 (27)
Missing	3	1

Table 2.12: Baseline mRS and NIHSS Score Recorded During Initial Presentation in 2024

Baseline mRS (prior to stroke), n (%)	
n	1487
Median (IQR)	0 (1)
0	1146 (77.1)
1	171 (11.5)
2	65 (4.3)
3	84 (5.6)
4	69 (4.6)
5	22 (1.5)
Missing	1203 (43.6)
NIHSS Stroke Severity n (%)	
0 (No Stroke Symptom)	1124 (13.2)
1-4 (Mild)	3080 (36.1)
5-15 (Moderate)	2998 (35.1)
16-20 (Moderate to Severe)	579 (6.8)
21-42 (Severe)	751 (8.8)

CHAPTER 3: HYPERACUTE REPERFUSION THERAPY FOR ISCHAEMIC STROKE IN 2024

- **IVT Rate: 16.4%** of ischaemic stroke patients received intravenous thrombolysis (IVT), which is below international targets (20–25%). Protocol adherence was high (97.3% used alteplase at standard dose).
- **Workflow:** Despite a low IVT rate primarily attributable to late presentation, the **median onset-to-door time among IVT-treated patients was 119 minutes**. In-hospital treatment time is on target (**median door-to-needle time of 60 minutes**).
- **MT Access:** The mechanical thrombectomy (MT) rate is **critically low at 1.6%**, primarily due to the **lack of service availability** across many hospitals.
- **Technical Performance for MT:** Procedural success was adequate, achieving a 62.1% successful recanalization rate (TICI 2B–3).
- **Core Issue:** Overall reperfusion performance is severely limited by the **lack of MT access** and the significant **late presentation**, necessitating expansion of MT centres and public awareness campaigns.

This report summarises the hyperacute reperfusion therapy provided for patients with ischaemic stroke across participating hospitals in the Malaysia National Stroke Registry in 2024. The data reflect real-world practice in intravenous thrombolysis and mechanical thrombectomy. A total of 2,405 stroke patients were captured in the registry for this period, of whom 2,294 had ischaemic stroke (**Table 3.1**).

Table 3.1: Total Stroke Patients, Ischaemic Stroke, Thrombolysis and Thrombectomy in 2024

Year- 2024	n
Total stroke patients	2405
Total ischaemic stroke	2294
Numbers of patients received thrombolysis	376
Number of patients received mechanical thrombectomy	37

Intravenous Thrombolysis (IVT)

Referring to **Table 3.2**, a total of 376 patients with ischaemic stroke received intravenous thrombolysis, representing 16.4 % of the ischaemic stroke population in the registry. The IVT rate of 16.4% aligns with many regional stroke registries but remains below the 20–25% benchmark achieved in high-performing international systems (*Mikulik et al., 2021*).

Regarding the thrombolytic agent used, alteplase was administered in 97.3% (n = 366) of patients, while tenecteplase was used in 2.7% (n = 10). The standard dose of 0.9 mg/kg was applied in 90.1% (n = 329), a lower dose of 0.6 mg/kg in 4.4% (n = 16), and dose information was missing in 5.5 % (n = 21).

For 2024, the median onset-to-door time was 119 minutes (IQR 112), the median imaging-to-needle time was 34 minutes (IQR 32), and the median door-to-needle time was 60 minutes (IQR 45). These results suggest that imaging turnaround and door-to-needle performance are within acceptable benchmarks, with the median door-to-needle time meeting the international target of ≤ 60 minutes.

The most frequent reasons for not performing thrombolysis included arrival outside the treatment window (n = 807), mild neurological deficits (n = 346), and specific contraindications (n = 73) such as uncontrolled blood pressure (n = 14), active bleeding (n = 5), warfarin with an INR > 1.7 (n = 2), and NOAC use within 48 hours (n = 7). Other reasons were unknown onset (n = 39), lack of consent (n = 6), transferred to another hospital for IVT (n = 2), cost concerns (n = 1), cases that requiring only mechanical thrombectomy (n = 4), haemorrhagic transformation (n = 6), and large infarcts involving more than one-third of the hemisphere (n = 10). A total of 58 patients (15.4%) experienced haemorrhagic transformation following IVT before discharge, a rate comparable to international registry findings.

Strengths of current practice include excellent adherence to dosing standards, with 90.1% of patients receiving the standard-dose alteplase, and an encouraging median door-to-imaging time of 34 minutes, reflecting efficient emergency triage.

Areas for improvement include reducing the median door-to-needle time, which, at 60 minutes, met but did not surpass optimal targets (< 45 minutes). The median onset-to-door time of 119 minutes indicated late presentation, underscoring the need for enhanced public awareness and improved emergency medical service pre-notification. A small yet important proportion of patients experienced post-thrombolysis haemorrhagic transformation, which is consistent with real-world registry variability.

Table 3.2: Number and Percentages of Thrombolysis, Alteplase and Tenecteplase During Acute Treatment

Acute Treatment	n (%)
Number of patients received thrombolysis	376 (16.4)
Number of patients received alteplase	366 (97.3)
Number of patients received tenecteplase	10 (2.7)
Alteplase dose (mg/kg)	**n (%)**
0.6	16 (4.4)
0.9	329 (90.1)
Missing	21 (5.5)
Reasons for not thrombolysed	**n**
Out of time window	807
Mild deficit	346
Contraindicated to IVT	73
Unknown onset	39
Received IV thrombolysis at other hospital	15
Uncontrolled BP	14
Stroke >1/3 hemisphere	10
Patient on NOAC within 48 hours	7
Consent not given	6
Haemorrhagic transformation	6
Active bleeding	5
Only mechanical thrombectomy required	4
Transferred to other hospital for IVT	2
Warfarin with INR >1.7	2
Financial constraint	1
Number of patients received mechanical thrombectomy	37 (1.6)

Mechanical Thrombectomy (MT)

As in **Table 3.3**, mechanical thrombectomy was undertaken in 37 patients (1.6%), highlighting limited national access, with most procedures performed at a single high-volume centre (SGH). The median door-to-groin puncture time was 110 minutes (IQR 73), while the median groin puncture-to-reperfusion time was 38 minutes (IQR 51). These values are in line with recommended international performance targets.

In terms of procedural success, complete recanalization (TICI 3) was achieved in 37.8% (n = 14) and partial recanalization (TICI 2B or 2C) in 24.3 % (n = 9). Unsuccessful cases (TICI 0–2A) comprised 16.2% (n = 6), while TICI data were unavailable in 21.6% (n = 8). Overall, successful recanalization (TICI 2B–3) was obtained in 62.1% of cases.

The number of devices passes varied, with single-pass success in 10.8%, two passes in 10.8%, three passes in 8.1%, five passes in 10.8%, and eight passes in 2.7% of cases. Data on the number of passes were missing in 56.8%. The aspiration technique was used in 83.8% of procedures, stent retrievers in 8.1%, and adjunct angioplasty in 10.8%.

The principal reasons for not performing thrombectomy were lack of service availability (n = 1,392), arrival outside the therapeutic window (n = 216), mild neurological deficit (n = 158), and absence of large vessel occlusion (n = 83). Other reasons included large ischaemic cores (n = 14), unknown onset (n = 19), lack of consent (n = 3), transfer to another hospital (n = 5), and cost limitations (n = 6).

Haemorrhagic transformation occurred in 21.6% (n = 8/37) of MT-treated patients prior to discharge, a slightly higher rate than that observed following IVT, consistent with the more severe baseline stroke severity (median NIHSS 16).

The mechanical thrombectomy rate of 1.6% remains markedly low, reflecting system-level barriers rather than clinical contraindications. The absence of service availability for many hospitals (n = 1,392) represents the principal limitation. Expansion of thrombectomy-capable centres and a hub-and-spoke referral network would be crucial to increasing national access. Technical performance appears adequate, with a 62.1% rate of successful recanalization (TICI 2B–3), though data completeness requires improvement. Median door-to-groin puncture time (110 minutes) indicated good procedural readiness once patients were selected, but pre-procedural processes such as imaging and referral contributed to delays (**Table 3.6**)

Patients receiving reperfusion therapies demonstrated meaningful neurological improvement, with median NIHSS scores improving from 11 to 5 for IVT cases.

Nevertheless, residual disability (mRS 3–4 at discharge) remained common, reinforcing the importance of timely treatment initiation. Comparative data from **Table 3.4** shows stable or improving workflow metrics year on year, yet further reduction in onset-to-door time is essential to optimise outcomes.

Table 3.3: Number and Percentages of Mechanical Thrombectomy During Acute Treatment

TICI Score	n (%)
Grade 0	4 (10.8)
Grade 2A	2 (5.4)
Grade 2B	2 (5.4)
Grade 2C	7 (18.9)
Grade 3	14 (37.8)
Not Available	8 (21.6)
Number of passes	**n (%)**
1	4 (10.8)
2	4 (10.8)
3	3 (8.1)
4	0
5	4 (10.8)
6	0
7	0
8	1 (2.7)
9	0
10	0
Not available	21 (56.8)
Device used	**n (%)**
Stent retriever	3 (8.1)
Aspiration	31 (83.8)
Angioplasty	4 (10.8)
Reasons thrombectomy not performed	**n**
Service not available	1392
Out of time window	216
Mild deficit	158
No LVO	83
Unknown onset	19
Large core (ASPECTS <5 + core volume >70ml)	14
Premorbid disability	7
Financial constraint	6
Transferred to another hospital for mechanical thrombectomy	5
Consent not given	3
Received a thrombectomy in another hospital	1

Table 3.4: Time Metrics for Stroke Patients (2017-2024)

	2024	2023	2022	2021	2020	2019	2018	2017
All stroke patients (Duration of onset-to-door)								
n	2420	1105	870	948	1132	1001	1699	1914
Mean (SD)	1267.0 (2149.46)	1178.4 (1968.50)	1280.7 (2467.06)	1154.2 (1941.75)	1221.1 (2148.22)	1396.8 (2305.33)	1430.1 (2492.20)	1422.0 (2247.35)
Median (IQR)	394.0 (140.0–1306.3)	362.0 (141.0–1302.0)	367.0 (141.0–1287.5)	421.5 (172.8–1152.3)	378.5 (150.0–1231.0)	517.0 (199.0 – 1552.3)	472 (178.5–1431.5)	507 (190.0–1599.75)
Missing	351	36	1	8	5	7	22	16
All stroke patients (Duration of door-to-imaging)								
n	2549	1087	834	936	1118	978	1709	1824
Mean (SD)	221.9 (632.08)	220.8 (411.07)	183.4 (343.77)	181.5 (506.20)	221.4 (521.25)	252.07 (506.05)	224.04 (559.37)	255.9 (702.93)
Median (IQR)	62.0 (30.0–141.0)	71.0 (31.0–191.0)	72 (31.0–190.75)	51.0 (24.0–116.5)	57.5 (28.0–130.0)	65.0 (38.0–121.0)	73.0 (38.0–151.0)	72.0 (41.0–147.25)
Missing	222	54	37	12	9	30	12	106

Patient Outcomes

Referring to **Table 3.5** and **Table 3.6**, among treated patients, the median NIHSS on admission was 11 for IVT and 16 for MT, indicating moderate-to-severe stroke severity. The median NIHSS at discharge improved to 5 for IVT, though data for MT were incomplete.

The median mRS on admission was 0, while the median mRS at discharge was 3 for IVT and 4 for MT. These results highlight that most patients had significant functional impairment at discharge, consistent with the moderate-to-severe stroke severity at presentation; functional recovery, however, typically continues beyond hospital discharge.

Imaging findings demonstrated a median ASPECT score of 9 (IQR 3), suggesting small-to-moderate early ischaemic changes in most treated patients. The rates of haemorrhagic transformation were 15.4% (n = 58) among IVT patients and 21.6 % (n = 8) among MT patients, emphasising the importance of careful case selection and early imaging-based triage to minimise risk.

Table 3.5: Ischaemic Stroke Patients Received Thrombolysis (Time Metrics and Functional Status at Admission & Discharge) in 2024

	Mean (SD)	Median (IQR)
Duration of onset-to-door, minutes	114.9 (68.5)	112.0 (63.0-168.0)
Duration of imaging-to-needle, minutes	39.6 (28.3)	34.0 (20.0-52.5)
Duration of door-to-needle, minutes	72.3 (49.6)	60.0 (35.0-95.0)
ASPECT Score		9 (3)
mRS at baseline		0 (0-2)
mRS at discharge		3 (1-5)
NIHSS at presentation		11 (6-7)
NIHSS at discharge		0 (0-4)
Haemorrhagic transformation		n = 58 (15.4%)

Table 3.6: Ischaemic Stroke Patients Received Thrombectomy (Time Metrics and Functional Status at Admission & Discharge) in 2024

	Mean (SD)	Median (IQR)
Duration of door-to-groin puncture, minutes	130.0 (67.9)	110 (73)
Duration of groin puncture to reperfusion time, minutes	56.1 (37.2)	38 (51)
mRS at baseline		0 (0, 2)
mRS at discharge		4 (2, 6)
NIHSS at presentation		5 (1, 6)
NIHSS at discharge		0 (0, 2)
Haemorrhagic transformation		n = 8 (21.6%)

CHAPTER 4: POST-ACUTE CARE AND COMPLICATIONS

- **Glucose control and fever:** 18.7% failed to achieve glucose <10 mmol/L within 48 hours; 6.6% developed fever—both linked to poorer outcomes.
- **VTE prophylaxis:** Most received pharmacological prevention; 48 used pneumatic compression, and 16 used compression stockings, though the latter are not recommended.
- **AF screening:** 77.5% were screened; 10.2% diagnosed with AF, showing improved detection from earlier reports.
- **Diagnostic workup:** Echocardiogram was most common (38.3%), followed by CTA/MRA (18.6%) and Holter (16.7%), limited by device access.
- **Rehabilitation:** Over 90% of patients with functional deficits received physiotherapy and occupational therapy; swallowing assessment was done in most patients.
- **Medical therapy:** 56.8% received antihypertensives, 30.1% antidiabetics, and 77.4% lipid-lowering agents.
- **Secondary prevention:** SAPT (42.2%) was more common than DAPT (35.1%); NOACs were preferred over warfarin for cardioembolic stroke.

Post-acute care

Post-acute care involves management to improve outcomes and prevent complications. To optimize patient outcome, 2 bedside parameters were investigated, which were sugar control and fever.

Strict sugar level control is one of the most important parameters, with an ideal target of <10mmol/L. However, in 2024, 18.7% of patients failed to achieve such a target within 48 hours of stroke, which might contribute to poorer outcomes.

In addition, 6.6% of patients developed fever in the first 72 hours of admission. This was significant as it contributed to prolonged hospital stay.

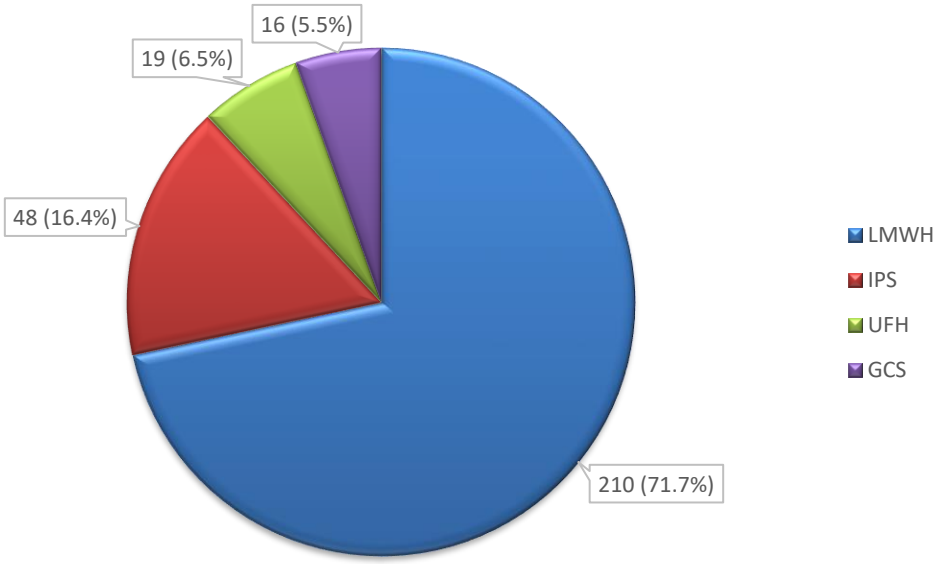


Figure 4.1: Types of VTE Prophylaxis Prescribed

Pharmacological and mechanical venous thromboembolism (VTE) prophylaxis were primarily prescribed for primary prevention. Pharmacological methods were the most frequently used, while 48 patients received intermittent pneumatic compression devices and 16 patients were provided with graduated compression stockings (**Figure 4.1).** The majority of patients (N = 2066) did not receive any form of VTE prophylaxis, as approximately half of the cohort had mRS scores below 2. Despite recommendations discouraging the use of graduated compression stockings due to their ineffectiveness in preventing VTE and potential to cause skin pressure injuries, some patients were still being prescribed *(Olsen et al., 2003).*

Identifying the aetiology of stroke is essential in post-acute care to decide an appropriate secondary preventive strategy. Most of the stroke patients (77.5%) were screened for atrial fibrillation (AF) on admission, and in total, 139 patients were newly diagnosed as having AF, which contributed to 5.0% of the total patients. Considering patients with pre-existing AF, we can conclude that 10.2% of stroke patients have AF. This figure might be underestimated as 13.7% of patients were not screened (**Figure 4.2**). Nonetheless, a higher incidence of AF was detected in 2024, as compared to the previous report (3.4%) (*Aziz & Sidek, 2016*). This could be due to better access to screening tools and higher awareness among physicians treating strokes. Thus, it is justifiable to maintain a high vigilance in screening for AF.

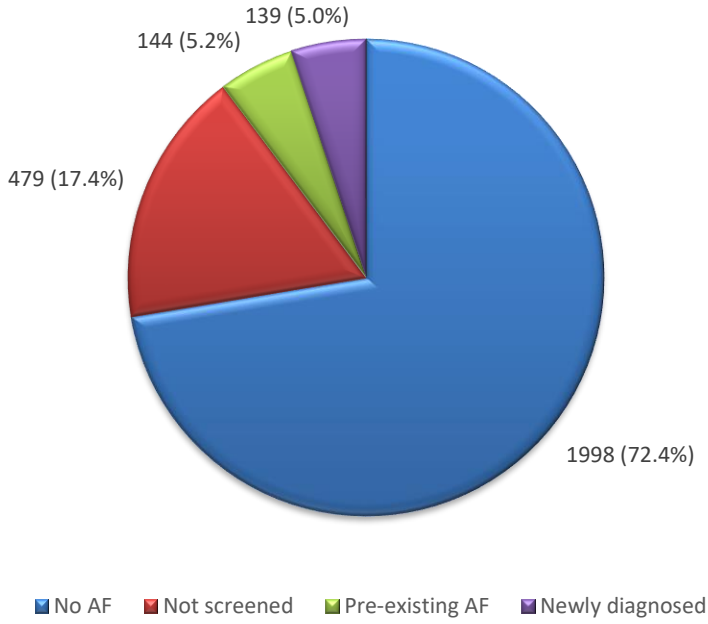


Figure 4.2: Prevalence of AF in Stroke Patients (2024)

Table 4.1: Methods Used in Identifying Stroke Aetiology

Imaging/Investigation	Number of patients (n)
Echocardiography	1058
Holter	460
CTA/MRA	512
Carotid ultrasonography	397
Transcranial Doppler	3
Diabetes screening	942
Fasting lipid profile	1151
Young stroke workup	35
Cancer screening	1

Different aetiologies and risk factors of stroke were investigated via various methods (**Table 4.1**). The most used method was echocardiogram (38.3%), which is useful in detecting dilated cardiac chambers, valvular heart disease, and intracardiac thrombus.

In comparison, Holter monitoring and CTA/MRA were performed in a lesser number of patients, 16.7% and 18.6% respectively. The lower prevalence of Holter monitoring being

ordered could be due to many strokes being atherosclerotic in origin or lack of access to the device. Young stroke workup was performed in 17.9% of patients younger than 40 years old.

Regarding early rehabilitation in the ward, a total of 2424 patients received swallowing assessment, whereas 2336 patients received physiotherapy, and 2219 patients received occupational therapy (OT) assessment. For patients with significant dysfunction (mRS 3-5), up to 95.8% and 93.8% received physiotherapy and OT, respectively.

In comparison with previous years' data (*Aziz & Sidek, 2016*), there was further improvement in the involvement of rehabilitation services (physiotherapy and OT) in post-stroke care (**Figure 4.3**).

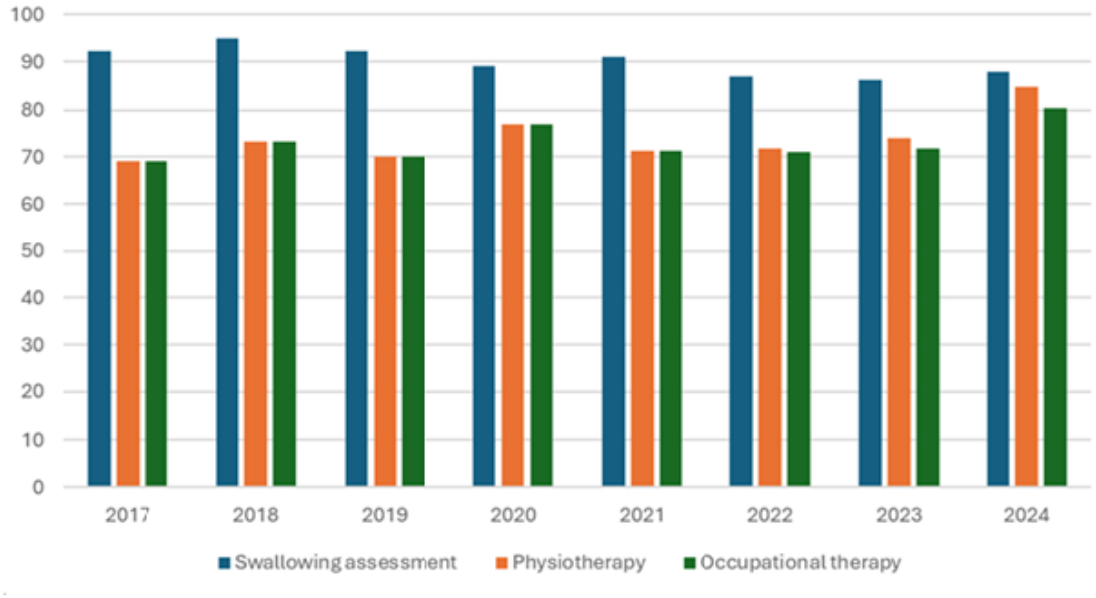


Figure 4.3: Percentage of Patients Who Received Rehabilitation

Finally, 1569 patients (56.8%) received anti-hypertensive treatment, 831 patients (30.1%) received anti-diabetic treatment, and 2137 patients (77.4%) were prescribed lipid-lowering agents.

Secondary Prevention (2024 data)

Most of the stroke patients received antiplatelet therapy as secondary prevention, as atherosclerotic stroke was the most common. Only 35.1% of patients were discharged with dual antiplatelet therapy (DAPT), while 47.2% of patients were discharged with single antiplatelet therapy (SAPT), despite 58% of patients with ischaemic stroke having small vessel occlusion or large artery atherosclerosis subtypes. Antiplatelets used other than aspirin and clopidogrel include ticlopidine, ticagrelor, and dipyridamole. (**Table 4.2**, **Figure 4.4**).

DAPT is recommended for mild stroke and stroke with symptomatic intracranial/extracranial atherosclerotic disease *(Olsen et al., 2003).* Despite that, it was being prescribed in a lesser trend compared to SAPT, probably due to concern of increased bleeding risk in certain patient groups (e.g.: elderly, chronic kidney disease, poorly controlled hypertension).

On the other hand, anticoagulants are indicated in cardioembolic stroke, and most patients in 2024 were discharged with non-vitamin K antagonist oral anticoagulants (NOAC), as compared to warfarin (**Figure 4.5**). A higher proportion of patients with cardioembolic stroke were prescribed NOAC compared to warfarin, in keeping with the available evidence showing superiority of NOAC in secondary prevention of cardioembolic stroke *(Patel et al., 2017).*

Table 4.2: Antiplatelet Therapy Use Among Patients with Ischaemic Stroke

Antiplatelet	n (%)
SAPT	1066 (47.2)
DAPT	794 (35.1)
None	381 (16.9)
Missing data	19 (0.8)

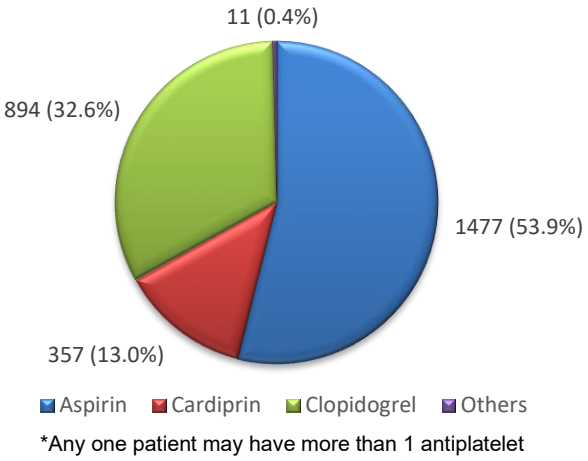


Figure 4.4: Types of Antiplatelet Used

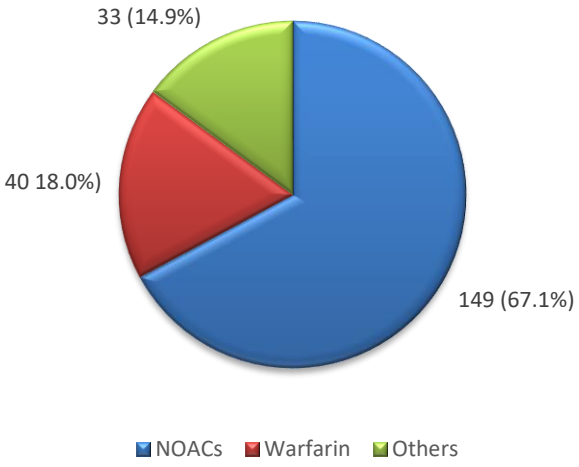


Figure 4.5: Types of Anticoagulants Prescribed

CHAPTER 5: STROKE OUTCOME

- **Survival and mortality:** Overall survival ranged from 91%–95%, higher in ischaemic than haemorrhagic strokes; haemorrhagic mortality peaked at 19.4% in 2024.
- **Functional outcomes:** About 44% of patients were independent (mRS 0–2) at discharge, while ~49% required assistance (mRS 3–5); improvement noted compared to 2009–2016, but disability remains substantial.
- **In-hospital complications:** Pneumonia (13.5%) and deep vein thrombosis (5.5%) were the most common, highlighting crucial areas for infection control and mobility support.
- **Secondary prevention:** Most ischaemic stroke patients received antiplatelets, with single antiplatelet therapy more common than dual therapy; NOACs were preferred over warfarin for cardioembolic stroke.

Survival and Mortality Rates (2017-2024)

Survival rates for all strokes ranged from 91.1% (2024) to 95.3% (2022), with an average of approximately 93% across the period (**Table 5.1**). The data reveal sustained high survival rates, suggesting advancements and improvements in acute stroke management in various hospitals. Ischaemic strokes consistently showed higher survival compared to haemorrhagic strokes. Mortality remained highest among haemorrhagic stroke cases, reaching 19.4% in 2024 (**Table 5.2**). The trend of poorer outcomes was also reflected in the complication rates, highlighting the need for subtype-specific management protocols, such as the Acute Bundle of Care for Intracerebral Haemorrhage (ABC-ICH) *(Parry-Jones et al., 2019).*

Table 5.1: Total Percentage of Survival among Ischaemic Stroke Subtypes

Year	Survival Rate (%)
2017	92.4
2018	94.4
2019	93.2
2020	93.8
2021	93.0
2022	95.3
2023	91.6
2024	91.1

Table 5.2: Yearly Total Mortality with Stroke Subtypes

Year	Total Mortality, n (%)	Ischaemic, n (%)	Haemorrhagic, n (%)
2017	139 (7.6)	100 (6.5)	38 (6.4)
2018	96 (5.5)	66 (4.6)	29 (15.2)
2019	71 (6.8)	50 (5.9)	19 (15.7)
2020	56 (4.8)	41 (4.4)	13 (8.8)
2021	67 (7.0)	49 (6.2)	17 (15.6)
2022	40 (4.7)	36 (4.6)	4 (7.1)
2023	95 (8.4)	78 (0.8)	13 (11.7)
2024	241 (8.9)	182 (8.0)	57 (19.4)

Functional Outcome Upon Discharge

Overall, in 2017-2024, the average functional outcome upon discharge where a patient was able to achieve functional independence, which is mRS 0-2, is about 43.6%. On the other hand, 48.9% of the Malaysian stroke population from 2017-2024 needed some form of assistance (mRS 3-5) for activities of daily living due to various degrees of physical or cognitive disability (**Figure 5.1**).

There was an overall increment in average functional independence and a reduction in functional dependency compared to the years 2009-2016, as in the previous report (*Aziz & Sidek, 2016).* Despite there's improvement over the functional outcomes, there was still a substantial proportion of stroke survivors who faced moderate to severe disability, underscoring long-term socioeconomic burdens such as reduced workforce participation and increased caregiver needs *(Jamnan et al., 2025)*

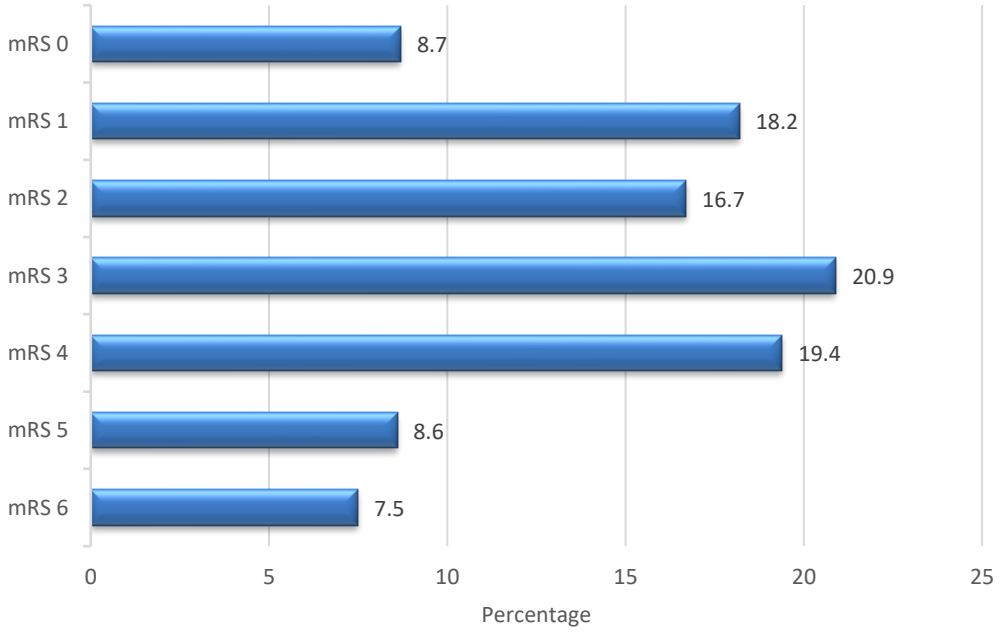


Figure 5.1: Average Functional Outcome Upon Discharge 2017-2024

In-Hospital Complications (2024 Data)

Starting in 2024, the registry had started collecting data on stroke complications during hospitalization. Among 2,760 documented stroke cases (2,293 ischaemic and 302 haemorrhagic), 75.9% experienced no complications during hospitalization. Pneumonia was the most prevalent complication at 13.5%, followed by deep vein thrombosis (5.5%) and haemorrhagic complications (5.5%). Haemorrhagic strokes exhibited higher rates of complications overall, particularly pneumonia (25.2% vs. 12.9% in ischaemic) and delirium (2.6% vs. 1.2%) (**Table 5.3**). In-hospital complications, including pneumonia and deep vein thrombosis, pointed to crucial aspects of care where infection control and mobility management could be strengthened *(Campagnini et al., 2025).*

Table 5.3: Stroke Complications during Hospitalization in 2024

Complication	%
None	75.9
Pneumonia	13.5
Deep vein thrombosis	5.5
Haemorrhagic complication	5.5
Recurrence/extension of stroke	2.5
Infection	1.6
Seizure	1.4
Delirium	1.3
Pressure sores	0.8
Pulmonary embolism	0.4
Drip site sepsis	0.4
Urinary tract infection	0.3
Depression	0.3
UGIB	0.3

SUMMARY OF REPORT

Between 2017 and 2024, registry data from Malaysian hospitals indicated that stroke was occurring at a relatively younger age, with men and individuals of Malay ethnicity comprising the majority of cases. Hypertension, diabetes mellitus, dyslipidaemia, and smoking remained the most prevalent vascular risk factors, with an increasing burden of hypertension and diabetes observed over time. Multimorbidity was more commonly observed among patients with ischaemic stroke, whereas haemorrhagic stroke cases tended to present with fewer comorbid conditions. Ischaemic stroke accounted for the majority of cases, with small vessel disease and lacunar infarctions predominating, a pattern consistent with reports from other Asian populations. Although haemorrhagic strokes were less frequent, they were associated with distinct risk profiles and clinical characteristics. Late arrival to the hospital remained a challenge, with patients relying on both emergency medical services and private transport. Most patients presented with mild to moderate stroke severity and were functionally independent prior to the index event. Acute stroke care demonstrated generally good adherence to thrombolysis protocols; however, access to mechanical thrombectomy and advanced neuroimaging remained limited. Post-acute management emphasised glycaemic control, AF screening, mechanical VTE prophylaxis, and targeted secondary prevention using antiplatelet agents and NOACs. Functional outcomes at discharge indicated that a substantial proportion of survivors continue to require assistance, underscoring the importance of timely and comprehensive rehabilitation services. In-hospital complications, including pneumonia and deep vein thrombosis, highlighted ongoing needs for improved infection prevention and early mobilisation strategies.

Limitation

The findings presented in this report are derived from data contributed by participating hospitals and reflect real-world clinical practice across heterogeneous healthcare settings in Malaysia. As registry participation is observational and voluntary, several inherent limitations must be acknowledged. First, the data do not represent complete national population coverage, and variations in reporting practices across sites are expected. Neurologist-centred participation may have resulted in under-representation of smaller, non-specialist, or rural hospitals, potentially limiting generalisability. Second, reliance on manual data entry introduces variability in data completeness and accuracy. This limitation is particularly relevant for advanced imaging variables, including CTA, CTP, and ASPECT scoring. Imaging utilisation could not be stratified by hospital capability (comprehensive stroke

centres versus non-comprehensive centres), nor were temporal trends in imaging access examined.

Incomplete documentation of ASPECTS and perfusion parameters further constrained interpretation of imaging-based eligibility for reperfusion therapies. Third, the low reported rates of CTA and CTP must be interpreted within the context of structural and resource constraints in the Malaysian healthcare system (*Chin et al., 2025).* Variability in scanner availability, limited access to trained radiographers and radiologists, and inconsistent after-hours imaging coverage particularly outside major tertiary centres are likely contributors to underutilisation and under-reporting of advanced imaging. These system-level limitations may have led to under-identification of large vessel occlusion and, consequently, underestimation of eligibility for mechanical thrombectomy. In addition, procedural details related to mechanical thrombectomy and post-discharge outcome follow-up were incompletely captured, restricting comprehensive evaluation of the relationship between imaging access, treatment selection, and clinical total of 11,413 outcomes.

Implications of Findings

The findings highlight important implications for strengthening stroke services across the continuum of care in Malaysia. The relatively younger age at stroke onset and the high burden of modifiable risk factors reinforce the need for stronger primary prevention and risk factor control at the community and primary care levels. Persistent late presentation and limited access to advanced acute interventions further indicate gaps in pre-hospital systems, emergency triage, referral pathways, and access to timely diagnostic imaging. At the acute care level, improving access to advanced neuroimaging should be prioritised as a national strategy, given that imaging is the essential gateway to reperfusion therapy.

A phased, system-level approach is warranted, including the designation and strengthening of comprehensive stroke centres with guaranteed 24-hour CT angiography capability, clear imaging-based referral criteria for mechanical thrombectomy, and streamlined inter-hospital transfer pathways. Standardised national stroke imaging protocols, supported by tele-radiology and tele-stroke networks may help mitigate disparities in scanner availability, specialist staffing, and after-hours access, particularly in non-tertiary and regional hospitals. These measures are consistent with international recommendations that emphasise equitable imaging access as a prerequisite for timely thrombolysis and thrombectomy, as outlined by the World Stroke Organization (*Lindsay et al., 2014).*

Addressing these gaps will require coordinated input beyond hospital-based stroke teams. Emergency Department physicians, neurosurgeons, interventional specialists, and rehabilitation professionals each contribute critical perspectives, from triage bottlenecks to infrastructure readiness and functional recovery outcomes. At a system level, this registry serves as a critical national benchmark for monitoring stroke care quality, particularly aligned with Malaysia's National Stroke Action Plan for hyperacute stroke services embedded within Rancangan Malaysia Ke-13 (RMK-13), RMK-14, and beyond. Strengthening this registry through expanded hospital participation and the systematic integration of multidisciplinary stakeholder input will enhance its capacity to inform evidence-based national stroke policy and service planning *(Chin et al., 2025).*

REFERENCES

1. Asaithambi, G., Tong, X., Lakshminarayan, K., Coleman King, S. M., George, M. G., & Odom, E. C. (2022). Emergency medical services utilization for acute stroke care: Analysis of the Paul Coverdell National Acute Stroke Program, 2014–2019. Prehospital Emergency Care, 26(3), 326–332. https://doi.org/10.1080/10903127.2021.1877856
2. Aziz, Z. A., & Sidek, N. N. (2016). Annual report of the Malaysian Stroke Registry 2009–2016.
3. Bosch, J., Lotlikar, R., Melifonwu, R., Roushdy, T., Sebastian, I., Abraham, S. V., Benjamin, L., Li, D., Ford, G., Heldner, M., Langhorne, P., Liu, R., Malewezi, E., Olaleye, O. A., Pandian, J., Urimubenshi, G., Waters, D., Zhao, J., & Rudd, A. (2025). Prehospital stroke care in low- and middle-income countries: A World Stroke Organization (WSO) scientific statement. International Journal of Stroke, 20(8), 918–927. https://doi.org/10.1177/17474930251351867
4. Campagnini, S., Sodero, A., Baccini, M., Hakiki, B., Grippo, A., Macchi, C., Mannini, A., & Cecchi, F. (2025). Prediction of the functional outcome of intensive inpatient rehabilitation after stroke using machine learning methods. Scientific Reports, 15, 16083. https://doi.org/10.1038/s41598-025-00781-1
5. Chin, C. J., Albart, S. A., Yusof Khan, A. H. K., Wan, W. A., Sidek, N. N., Ping, S. J., et al. (2025). An overview of hyperacute stroke services and the National Stroke Registry in Malaysia: Improving stroke care through evidence. Medical Journal of Malaysia, 75(Suppl 1), 29–36.
6. Department of Statistics Malaysia. (2025). Demographic statistics, second quarter 2025. https://statistics.gov.my/portal-main/release-content/demographic-statistics-second-quarter-2025
7. Department of Statistics Malaysia. (2025). Statistics on causes of death, Malaysia, 2025. https://www.dosm.gov.my/uploads/release-content/file_20251218114249.pdf
8. European Stroke Initiative Executive Committee, EUSI Writing Committee, Olsen, T. S., Langhorne, P., Diener, H. C., Hennerici, M., Ferro, J., Sivenius, J., Wahlgren, N. G., & Bath, P. (2003). European Stroke Initiative Recommendations for Stroke Management-update 2003. Cerebrovascular diseases (Basel, Switzerland), 16(4), 311–337. https://doi.org/10.1159/000072554
9. Fonarow, G. C., Reeves, M. J., Smith, E. E., Saver, J. L., Zhao, X., Olson, D. W., Hernandez, A. F., Peterson, E. D., Schwamm, L. H., & GWTG-Stroke Steering Committee and Investigators (2010). Characteristics, performance measures, and in-hospital outcomes of the first one million stroke and transient ischemic attack admissions in get with the guidelines-stroke. Circulation. Cardiovascular quality and outcomes, 3(3), 291–302. https://doi.org/10.1161/CIRCOUTCOMES.109.921858
10. Hauer, A. J., Ruigrok, Y. M., Algra, A., van Dijk, E. J., Koudstaal, P. J., Luijckx, G. J., Nederkoorn, P. J., van Oostenbrugge, R. J., Visser, M. C., Wermer, M. J., Kappelle, L. J., Klijn, C. J. M., & Dutch Parelsnoer Institute-Cerebrovascular Accident Study Group (2017). Age-Specific Vascular Risk Factor Profiles According to Stroke Subtype. Journal of the American Heart Association, 6(5), e005090. https://doi.org/10.1161/JAHA.116.005090
11. Jamnan, R., Kadar, M., Razaob, N. A. R., & Hussein, N. (2025). Factors influencing functional improvement, intervention and its outcome in post-stroke rehabilitation in community: A scoping review. Medicine & Health, 20(1), 52–65. https://doi.org/10.17576/MH.2025.2001.03

12. Kim, B. J., & Kim, J. S. (2014). Ischemic stroke subtype classification: An Asian viewpoint. Journal of Stroke, 16(1), 8–17. https://doi.org/10.5853/jos.2014.16.1.8
13. Kolominsky-Rabas, P. L., Wiedmann, S., Weingärtner, M., Liman, T. G., Endres, M., Schwab, S., Buchfelder, M., & Heuschmann, P. U. (2015). Time trends in incidence of pathological and etiological stroke subtypes during 16 years: The Erlangen Stroke Project. Neuroepidemiology, 44(1), 24–29. https://doi.org/10.1159/000371353
14. Lindsay, P., Furie, K. L., Davis, S. M., Donnan, G. A., & Norrving, B. (2014). World Stroke Organization global stroke services guidelines and action plan. International Journal of Stroke, 9(Suppl A100), 4–13. https://doi.org/10.1111/ijs.12371
15. Marnane, M., Duggan, C. A., Sheehan, O. C., Merwick, A., Hannon, N., Curtin, D., Harris, D., Williams, E. B., Horgan, G., Kyne, L., McCormack, P. M., Duggan, J., Moore, A., Crispino-O'Connell, G., & Kelly, P. J. (2010). Stroke subtype classification by TOAST, A-S-C-O, and causative classification system: Direct comparison in the North Dublin Population Stroke Study. Stroke, 41(8), 1579–1586. https://doi.org/10.1161/STROKEAHA.109.575373
16. McDonough, R. V., Ospel, J. M., Majoie, C. B. L. M., Saver, J. L., White, P., Dippel, D. W. J., Brown, S. B., Demchuk, A. M., Jovin, T. G., Mitchell, P. J., Bracard, S., Campbell, B. C. V., Muir, K. W., Hill, M. D., Guillemin, F., Goyal, M., & HERMES collaborators (2023). Clinical outcome of patients with mild pre-stroke morbidity following endovascular treatment: a HERMES substudy. Journal of neurointerventional surgery, 15(3), 214–220. https://doi.org/10.1136/neurintsurg-2021-018428
17. Mikulik, R., Bar, M., Cernik, D., Herzig, R., Jura, R., Jurak, L., Neumann, J., Sanak, D., Ostry, S., Sevcik, P., Skoda, O., Skoloudik, D., Vaclavik, D., & Tomek, A. (2021). Stroke 20 20: Implementation goals for intravenous thrombolysis. European stroke journal, 6(2), 151–159. https://doi.org/10.1177/23969873211007684
18. Mohd Nor, N. S., Chua, Y. A., Abdul Razak, S., et al. (2022). Identification of cardiovascular risk factors among urban and rural Malaysian youths. BMC Cardiovascular Disorders, 22, 70. https://doi.org/10.1186/s12872-021-02447-y
19. National Registry of Diseases Office. (2020). Singapore Stroke Registry annual report 2020. https://www.nrdo.gov.sg/docs/librariesprovider3/default-document-library/ssr-web-report-2020c544bb698cf04ad1aaaa7a1472296132.pdf
20. O'Donnell, M. J., Chin, S. L., Rangarajan, S., Xavier, D., Liu, L., Zhang, H., … INTERSTROKE investigators. (2016). Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): A case-control study. The Lancet, 388(10046), 761–775. https://doi.org/10.1016/S0140-6736(16)30506-2
21. Parry-Jones, A. R., Sammut-Powell, C., Paroutoglou, K., Birleson, E., Rowland, J., Lee, S., Cecchini, L., Massyn, M., Emsley, R., Bray, B., & Patel, H. (2019). An Intracerebral Hemorrhage Care Bundle Is Associated with Lower Case Fatality. Annals of neurology, 86(4), 495–503. https://doi.org/10.1002/ana.25546
22. Patel, P., Pandya, J., & Goldberg, M. (2017). NOACs vs warfarin for stroke prevention in nonvalvular atrial fibrillation. Cureus, 9(6), e1395. https://doi.org/10.7759/cureus.1395
23. Pinzon, R. T., & Karunawan, N. H. (2020). The Burden of Atrial Fibrillation as Stroke Risk Factor in Southeast Asia: A Systematic Review. Journal of Drug Delivery and Therapeutics, 10(1), 131-134. https://doi.org/10.22270/jddt.v10i1.3818
24. Rahbar, M. H., Medrano, M., Diaz-Garelli, F., Gonzalez Villaman, C., Saroukhani, S., Kim, S., et al. (2022). Younger age of stroke in low–middle-income countries is related

to healthcare access and quality. Annals of Clinical and Translational Neurology, 9(3), 415–427.* https://doi.org/10.1002/acn3.51507
25. Safe Implementation of Treatments in Stroke (SITS). (2017). SITS report 2017. https://sitsinternational.org/wp-content/uploads/2020/11/SITS-Report-2017-Final-version-website.pdf
26. Venketasubramanian, N. (2024). Stroke demographics, risk factors, subtypes, syndromes, mechanisms and inter-ethnic differences between Chinese, Malays and Indians in Singapore: A hospital-based study. Journal of Cardiovascular Development and Disease, 11(6), 180.* https://doi.org/10.3390/jcdd11060180
27. Wang, B., Bai, X., Yang, Y., Cui, J., Song, L., Liu, J., Lu, J., & Cai, J. (2022). Prevalence, treatment, and attributed mortality of elevated blood pressure among a nationwide population-based cohort of stroke survivors in China. Frontiers in Cardiovascular Medicine, 9, 890080. https://doi.org/10.3389/fcvm.2022.890080
28. Wiyarta, E., Hidayat, R., Kurniawan, M., Sinaga, G. H. P., & Budiman, R. A. (2025). Factors associated with prehospital and in-hospital delays in acute ischaemic stroke care in Indonesia: A systematic review. BMJ Open, 15(3), e095845. https://doi.org/10.1136/bmjopen-2024-095845
29. Yuan, J., Shan, G. L., Li, S. D., Gao, C. P., Cui, L. Y., Peng, B., & FAST-RIGHT Investigators and Coordinators (2021). Impact of regional differences in stroke symptom awareness and low-income status on seeking emergency medical service in China. Chinese medical journal, 134(15), 1812–1818. https://doi.org/10.1097/CM9.0000000000001604

LIST OF PUBLICATIONS

Num	Year	Details	Impact factor
1	2012	Nazifah, S. N., Azmi, I. K., Hamidon, B. B., Looi, I., Zariah, A. A., & Hanip, M. R. (2012). National Stroke Registry (NSR): Terengganu and Seberang Jaya experience. *The Medical journal of Malaysia*, *67*(3), 302–304. https://www.e-mjm.org/2012/v67n3/National-Stroke-Registry.pdf	0.209
2	2015	Aziz, Z. A., Lee, Y. Y., Ngah, B. A., Sidek, N. N., Looi, I., Hanip, M. R., & Basri, H. B. (2015). Acute Stroke Registry Malaysia, 2010-2014: Results from the National Neurology Registry. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*, *24*(12), 2701–2709. https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.07.025	1.599
3	2016	Aziz, Z. A., Sidek, N. N., Ngah B. A., Looi, I., Hanip, M. R., & Lee, Y. L. (2016). Clinical Characteristics of Atrial Fibrillation in First-ever Ischemic Stroke Patients; Results from Malaysia National Neurology Registry. *Int J Cardiovasc Res 5:5. https://doi.org/10.4172/2324-8602.1000278*	1.15
4	2016	Aziz, Z. A., Lee, Y. Y., Sidek, N. N., Ngah, B. A., Looi, I., Hanip, M. R., & Basri, H. B. (2016). Gender disparities and thrombolysis use among patient with first-ever ischemic stroke in Malaysia. *Neurological research*, *38*(5), 406–413. https://doi.org/10.1080/01616412.2016.1178948	1.55
5	2016	Hwong, W. Y., Bots, M. L., Selvarajah, S., Kappelle, L. J., Abdul Aziz, Z., Sidek, N. N., & Vaartjes, I. (2016). Use of a Diagnostic Score to Prioritize Computed Tomographic (CT) Imaging for Patients Suspected of Ischemic Stroke Who May Benefit from Thrombolytic Therapy. *PloS one*, *11*(10), e0165330. https://doi.org/10.1371/journal.pone.0165330	3.08
6	2016	Hwong, W. Y., Bots, M. L., Selvarajah, S., Abdul Aziz, Z., Sidek, N. N., Spiering, W., Kappelle, L. J., & Vaartjes, I. (2016). Use of Antihypertensive Drugs and Ischemic Stroke Severity - Is There a Role for Angiotensin-II?. *PloS one*, *11*(11), e0166524. https://doi.org/10.1371/journal.pone.0166524	3.08
7	2017	Hwong, W. Y., Abdul Aziz, Z., Sidek, N. N., Bots, M. L., Selvarajah, S., Kappelle, L. J., Sivasampu, S., & Vaartjes, I. (2017). Prescription of secondary preventive drugs after ischemic stroke: results from the Malaysian National Stroke Registry. *BMC neurology*, *17*(1), 203. https://doi.org/10.1186/s12883-017-0984-1	2.34

8	**2019**	Chen, X. W., Shafei, M. N., Aziz, Z. A., Sidek, N. N., & Musa, K. I. (2019). Trends in stroke outcomes at hospital discharge in first-ever stroke patients: Observations from the Malaysia National Stroke Registry (2009-2017). *Journal of the neurological sciences*, *401*, 130–135. https://doi.org/10.1016/j.jns.2019.04.015	3.115
9	**2019**	Aziz, S., Sheikh Ghadzi, S. M., Abidin, N. E., Tangiisuran, B., Zainal, H., Looi, I., Ibrahim, K. A., Sidek, N. N., Wei, L. K., Keng Yee, L., Abdul Aziz, Z., & Harun, S. N. (2019). Gender Differences and Risk Factors of Recurrent Stroke in Type 2 Diabetic Malaysian Population with History of Stroke: The Observation from Malaysian National Neurology Registry. *Journal of diabetes research*, *2019*, 1794267. https://doi.org/10.1155/2019/1794267	2.83
10	**2020**	Chen, X. W., Nazri Shafei, M., Abdul Aziz, Z., Nazifah Sidek, N., & Imran Musa, K. (2020). Modelling the prognostic effect of glucose and lipid profiles on stroke recurrence in Malaysia: an event-history analysis. *PeerJ*, *8*, e8378. https://doi.org/10.7717/peerj.8378	3.06
11	**2020**	Mohammed, M., Zainal, H., Tangiisuran, B., Harun, S. N., Ghadzi, S. M., Looi, I., Sidek, N. N., Yee, K. L., & Aziz, Z. A. (2020). Impact of adherence to key performance indicators on mortality among patients managed for ischemic stroke. *Pharmacy practice*, *18*(1), 1760. https://doi.org/10.18549/PharmPract.2020.1.1760	1.95
12	**2020**	Albitar, O., Harun, S. N., Abidin, N. E., Tangiisuran, B., Zainal, H., Looi, I., Ibrahim, K. A., Sidek, N. N., Loo, K. W., Lee, K. Y., Aziz, Z. A., & Ghadzi, S. M. S. (2020). Predictors of Recurrent Ischemic Stroke in Obese Patients With Type 2 Diabetes Mellitus: A Population-based Study. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*, *29*(10), 105173. https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.105173	2.677
13	**2020**	King, T. L., Tiong, L. L., Kaman, Z., Zaw, W. M., Abdul Aziz, Z., & Chung, L. W. (2020). A hospital-based study on ischaemic stroke characteristics, management, and outcomes in Sarawak: Where do we stand?. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*, *29*(9), 105012. https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.105012	2.677
14	**2020**	Loh, H. C., Nazri, N., Ganasegeran, K., Aziz, Z. A., & Looi, I. (2020). Socio-demographics and clinical characteristics affecting pre-hospital delays in acute stroke patients: A 6-year registry study from a Malaysian stroke hospital. Neurology Asia 2020; 25(3) : 235 – 243	0.759
15	**2021**	Elhefnawy, M. E., Sheikh Ghadzi, S. M., Tangiisuran, B., Zainal, H., Looi, I., Ibrahim, K. A., Sidek, N. N., Loo, K. W., Yee Lee, K., Abdul Aziz, Z., & Harun, S. N. (2021). Population-based Study Comparing Predictors of Ischemic Stroke Recurrence After Index Ischemic Stroke in Non-elderly Adults with or without Diabetes. *International journal of general medicine*, *14*, 1205–1212. https://doi.org/10.2147/IJGM.S303641	2.12

16	**2023**	Elhefnawy, M. E., Sheikh Ghadzi, S. M., Albitar, O., Tangiisuran, B., Zainal, H., Looi, I., Sidek, N. N., Aziz, Z. A., & Harun, S. N. (2023). Predictive model of recurrent ischemic stroke: model development from real-world data. *Frontiers in neurology*, *14*, 1118711. https://doi.org/10.3389/fneur.2023.1118711	4.086
17	**2023**	Ab Rahman, N, Law, W. C, Wan Zaidi, W. A., Abdul Aziz, Z., Sidek, N. N., Looi, I., Lim, M. T, Pang, S. H. L., Hwong, W. Y., & Sivasampu, S. (2023). Antiplatelet Therapy for Secondary Prevention in Patients with Ischaemic Stroke and Transient Ischaemic Attack: A Retrospective Cohort Study in Malaysia. Med & Health Dec 2023; 18(2): 480-497. https://doi.org/10.17576/MH.2023.1802.12	0.1
18	**2025**	Mohammed, M., Zainal, H., Ong, S. C., Tangiisuran, B., Aziz, F. A., Sidek, N. N., Sha'aban, A., Ibrahim, U. I., Muhammad, S., Looi, I., & Aziz, Z. A. (2025). Prognostic Models of Mortality Following First-Ever Acute Ischemic Stroke: A Population-Based Retrospective Cohort Study. *Health science reports*, *8*(2), e70445. https://doi.org/10.1002/hsr2.70445	2.1
19	**2025**	Chin, C. J., Albart, S. A., Yusof Khan, A. H. K., Wan Zaidi, W. A., Sidek, N. N., Schee, J. P., Looi, I., & Hoo, F. K. (2025). An overview of hyperacute stroke services and National Stroke Registry in Malaysia - Improving stroke care through evidence. *The Medical journal of Malaysia*, *80*(2), 266–274.	0.64
20	**2025**	Mohammed, M., Zainal, H., Ong, S. C., Tangiisuran, B., Aziz, F. A., Sha'aban, A., Abubakar, U., Sidek, N. N., Looi, I., & Aziz, Z. A. (2025). Direct medical cost of first-ever acute ischemic stroke in malaysia: a retrospective cohort study. *Scientific reports*, *15*(1), 22571. https://doi.org/10.1038/s41598-025-07026-1	3.9

APPENDIX: CASE REPORT FORM (CRF)

Available at: https://www.macr.org.my/nneur/fwbPage.jsp?fwbPageId=DataStandard

See next page

Notification Form

*Instruction: Where check boxes ☐ are provided, check (√) one or more boxes. Where radio buttons ○ are provided, check (√) one box only. * indicates compulsory field.*		Office use (ID)	/
1.	Name of Hospital		
2.	Date of Notification	__ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*	

A. PATIENT DEMOGRAPHICS					
1.	*Patient Name				
2.	*Patient Identification No	MyKad/MyKid			
		Other ID Document Type (Passport, Armed Force)		Other ID Document Number	
3.	*Date of Birth	__ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*			
4.	*Age at onset	__ __ __ years old *(Auto-calculated)*			
5.	*Sex	○ Male ○ Female			
6.	*Ethnicity	○ Malay ○ Chinese ○ Indian	○ Bumiputera Sarawak: _____ ○ Bumiputera Sabah: _____ ○ Other Malaysian: _____ ○ Foreigner, specify country: _____		

B. CLINICAL DETAILS					
1	***Hospital arrival**	a. Patient arrived to the hospital from	○ From home / scene → answer (i) i. If from home / scene, mode of arrival: ○ EMS / ambulance ○ private transportation ○ From another stroke treating centre ○ From any other hospital		
		b. Date & time of hospital arrival (Door time)	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*		
2	***Stroke onset**	a. In patient stroke	○ No ○ Yes		
		b. Stroke onset	○ Known onset →	i. Date & time of symptom onset	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*
				ii. Time of onset to door	__ __ __ minutes *(Auto-calculated if in patient stroke = No)*
			○ Unknown onset / wake up stroke →	iii. Date & time when patient went to bed / last seen well	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*
				iv. Time of onset to door	__ __ __ minutes *(Auto-calculated if in patient stroke = No)*
		c. Date & time of medical/ neurology team review	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*		
3	***Hospital admission**	a. Admitted?	○ No ○ Yes ↓ (answer b & c)		
		b. Date of admission	__ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*		
		c. Location of admission (day 1)	○ ICU ○ Stroke unit ○ Other monitored bed with telemetry ○ Standard bed		
4	***Risk factors**	Previous known history (select all that apply)	☐ None ☐ Diabetes mellitus ☐ Hyperlipidemia ☐ Previous TIA / ischemic stroke ☐ Atrial fibrillation / flutter (proxysmal / persistent / permanent) ☐ Valvular heart disease ☐ Chronic kidney disease ☐ Malignancy ☐ Gout ☐ Obesity ☐ Unknown	☐ Hypertension ☐ Smoker ↓ ○ Current ○ Former (>30 days) ☐ Previous hemorrhagic stroke ☐ Coronary artery disease / previous MI ☐ Congestive heart failure ☐ Hormonal contraception ☐ Covid positive in last 6 months ☐ HIV ☐ Family history of stroke ☐ Obstructive sleep apnoea (OSA) ☐ Other: _____	

Version 1.21 (Date: 30/10/2024)

5	***Prior medication** Treatment before admission / event (select all that apply)	☐ None	
		☐ *Antiplatelet →	☐ Aspirin (ASA) ☐ Cardiprin ☐ Clopidogrel ☐ Prasugrel ☐ Ticlopidine ☐ Cilostazol ☐ Ticagrelol ☐ Dipyridamole ☐ Other antiplatelet, specify: _____
		☐ *Anticoagulant →	☐ Warfarin ☐ Heparin/low molecular weight heparin ☐ Dabigatran ☐ Rivaroxaban ☐ Apixaban ☐ Edoxaban ☐ Other anticoagulant, specify: _____
		☐ Antidiabetic →	☐ Specify: _____
		☐ Anti-hypertensives →	☐ Specify: _____
		☐ Statin →	☐ Specify: _____
		☐ Other →	☐ Specify: _____
		☐ Unknown	
6	*Vital signs, neurological assessment & blood investigation at presentation	a. GCS	__ __ o Not done
		b. Systolic blood pressure	__ __ __ mmHg o Not done
		c. Diastolic blood pressure	__ __ __ mmHg o Not done
		d. Blood glucose	__ __. __ mmol/L OR o Lo o Hi o Not done
		e. LDL cholesterol	__ __. __ mmol/L o Not done
		f. NIHSS	__ __ o Not done
		g. Baseline mRS (prior to stroke)	o 0 o 1 o 2 o 3 o 4 o 5 o Not done
7	*Imaging	a.* Brain imaging type (select all that apply)	

#	Brain imaging type	Date & Time of imaging *(dd/mm/yyyy hh:mm) (24 hr clock)*	Door to CT/MRI *(Auto-calculated)*
i.	☐ Imaging done in another hospital		
ii.	☐ Non-contrast CT	__ __ / __ __ / __ __ __ __ __ __ : __ __	__ __ __ minutes
	☐ CT Angiography	__ __ / __ __ / __ __ __ __ __ __ : __ __	__ __ __ minutes
		1. Large vessel occlusion (LVO):	o No o Yes
		2. Middle vessel occlusion / Distal Vessel Occlusion (MEVO / DVO):	o No o Yes
		3. If Yes for either (1) or (2), select all that apply:	
		3a. ☐ Side	o Right o Left o Bilateral
		3b. ☐ Vessel occluded	
		3b i) ☐ MCA:	o M1 o M2 o M3 o M4
		3b ii) ☐ ACA:	o A1 o A2 o A3
		3b iii) ☐ Basilar:	o Proximal o Mid o Distal
		3b iv) ☐ Vertebral	
		3b v) ☐ PCA	
		3b vi) ☐ ICA	o Intracranial o Extracranial
		4. ICAD	o No o Yes ↓ Location: _____
iv.	☐ CT Perfusion	__ __ / __ __ / __ __ __ __ __ __ : __ __	__ __ __ minutes
v	☐ MR DWI / Flair	__ __ / __ __ / __ __ __ __ __ __ : __ __	__ __ __ minutes
vi.	☐ MR Angiography	__ __ / __ __ / __ __ __ __ __ __ : __ __	__ __ __ minutes
		1. Large vessel occlusion (LVO):	o No o Yes
		2. Middle vessel occlusion / Distal Vessel Occlusion (MEVO / DVO):	o No o Yes
		3. If Yes for either (1) or (2), select all that apply:	
		3a. ☐ Side	o Right o Left o Bilateral
		3b. ☐ Vessel occluded	
		3b i) ☐ MCA:	o M1 o M2 o M3 o M4
		3b ii) ☐ ACA:	o A1 o A2 o A3
		3b iii) ☐ Basilar:	o Proximal o Mid o Distal
		3b iv) ☐ Vertebral	

Version 1.21 (Date: 30/10/2024)

7	*Imaging			3b v) ☐ PCA	
				3b vi) ☐ ICA	o Intracranial o Extracranial
				4. ICAD	o No o Yes ↓
					Location: _____
		vii.	☐ MR Perfusion	__ __ / __ __ / __ __ __ __ __ __ : __ __	__ __ __ minutes
		viii.	☐ Not done		
		b. (Optional) Non-contrast CT / MRI findings:		1. ☐ Side	o Right o Left o Bilateral
				2. Area of infarct (select all that apply)	
				2a. Cortical	☐ MCA ☐ ACA ☐ PCA ☐ Cerebellar
				2b. Brainstem	☐ Midbrain ☐ Pontine ☐ Medulla
				2c. Subcortical	☐ Basal ganglia ↓ ☐ Corona radiate ☐ Centrum Semiovale
					☐ Internal capsule ☐ Caudate ☐ Putamen ☐ ☐ Caudate
		c. Old infarcts seen on the imaging (select all that apply)		☐ Cortical ☐ Subcortical (basal ganglia, internal capsule) ☐ Brainstem	☐ None ☐ Not available
		d. ASPECT Score		o 0 o 1 o 2 o 3 o 4 o 5 o 6 o 7 o 8 o 9 o 10	
8	*Stroke classifications	a. WHO classification		o Ischemic stroke o Transient ischemic attack (TIA) o Undetermined (the imaging finding is not available) o Determined	o Intracerebral haemorrhage o Subarachnoid haemorrhage
				i. If TIA, ABCD2 score	o 0 o 1 o 2 o 3 o 4 o 5 o 6 o 7
				ii. If ischemic stroke	
				a. OCSP classification	o TACI o PACI o LACI o POCI
				b. TOAST classification	o Large artery atherosclerosis o Small vessel occlusion o Cardioembolism o Other determined aetiologies o Undetermined aetiology
9	*IV thrombolysis treatment	a. Treated with IV thrombolysis in current admission		o No	o Yes
		i. If No		a. Reasons for not doing thrombolysis	☐ Already received IV thrombolysis in other hospital ☐ Out of time window ☐ Mild deficit ☐ Contraindicated to IVT ☐ Unknown onset ☐ Consent not given ☐ Cost of treatment ☐ Transferred to other hospital for IV thrombolysis → answer (b) b. Transfer date & time: __ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)* ☐ Only mechanical thrombectomy required ☐ Thrombolytic drug not available ☐ Uncontrolled BP ☐ Active bleeding ☐ Warfarin with INR >1.7 ☐ Patient on NOAC < 48hour ☐ Haemorrhagic transformation ☐ Stroke >1/3 of hemisphere ☐ Other: _____
		ii. If Yes		a. IVT agent (select one)	o Alteplase o Streptokinase o Tenecteplase o Staphylokinase
		ii. If Yes		b. Treatment dose	__ __ __ . __mg
				c. If Alteplase is used, select dose	o 0.9mg/kg o 0.6mg/kg o other dose (pls state) _____ mg/kg

Version 1.21 (Date: 30/10/2024)

			d. Bolus date & time (time at which first IV shot given)	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*	
			e. CT/MRI to needle time (in minutes)	__ __ __ __ *(Auto-calculated)*	
			f. Stroke onset to thrombolysis time (minutes)	__ __ __ __ *(Auto-calculated)*	
			g. Location of IV thrombolysis bolus administration	o CT / MRI room o Emergency room	o Stroke unit / ICU o Other: _____
10	*Mechanical thrombectomy treatment	a. Treated with mechanical thrombectomy in your hospital	o No	o Yes	o Service not available
		i. If No	a. Reason for not doing thrombectomy	☐ Already received mechanical thrombectomy in other hospital ☐ Out of time window ☐ Mild deficit ☐ Unknown onset ☐ Large core (ASPECT<5 + core volume >70ml ☐ No large vessel occlusion ☐ Premorbid disability ☐ Consent not given ☐ Cost of treatment ☐ Transferred to other hospital for mechanical thrombectomy b. Transfer date & time (door out): __ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)* ☐ Other: _____	
		ii. If Yes	a. Groin puncture date & time	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*	
			b. Reperfusion date & time	__ __ / __ __ / __ __ __ __ __ __ : __ __ *(dd/mm/yyyy hh:mm) (24 hr clock)*	
			c. Door to groin puncture time (in minutes)	__ __ __ __ *(Auto-calculated)*	
			d. Groin puncture to reperfusion time (in minutes)	__ __ __ __ *(Auto-calculated)*	
			e. TICI score	o Grade 0 o Grade 1 o Grade 2A o Grade 2B o Grade 2C o Grade 3	
			f. Number of passes	o 1 o 2 o 3 o 4 o 5 o 6 o 7 o 8 o 9 o 10	
			g. Device used	☐ Stent retriever ☐ Aspiration ☐ Angioplasty	
11	*Post Acute Care	a. Fever (equal or more than 37.5) in the first 72 hours of admission	o No	o Yes	
		b. Glucose level of equal or more than 10mmol/L in first 48 hours of admission	o No	o Yes	
		c. VTE prophylaxis (select all that apply)	☐ Unfractionated heparin (UFH) ☐ Intermittent pneumatic compression devices (IPC) ☐ Oral factor Xa inhibitor prescribed for VTE only	☐ Low molecular weight heparin (LMWH) ☐ Warfarin prescribed for VTE only ☐ Other, specify: _____ _____	☐ Graduated compression stockings (GCS) ☐ Venous foot pumps (VFP) ☐ None

Version 1.21 (Date: 30/10/2024)

11	*Post Acute Care	d. Screening for atrial fibrillation/flutter	○ Not screened ○ Known AF	○ No AF detected	○ Detected during hospitalization
		e. Swallowing assessment done	○ No	○ Yes	
		f. Patient received physiotherapy	○ No	○ Yes	○ Not required
		g. Patient received occupational therapy	○ No	○ Yes	○ Not required
		h. Patient received speech therapy	○ No	○ Yes	○ Not required
		i. Smoking cessation programme	○ No	○ Yes	○ Not required (non smoker)
12	*Post stroke complications	a. Post stroke complications (select all that apply)	☐ None ☐ Recurrence / extension of stroke ☐ Pulmonary embolism (PE) ☐ Delirium	☐ Pneumonia ☐ Deep vein thrombosis (DVT) ☐ Drip site sepsis ☐ Others, specify: _____	☐ Pressure sores ☐ Urinary tract infection ☐ Seizure
		b. Hemorrhagic transformation		○ No	○ Yes
		c. Neurosurgical intervention (decompressive craniectomy etc)		○ No	○ Yes
13	Secondary prevention work- up	a. Secondary prevention work-up (select all that apply)	☐ Echocardiography ☐ Carotid ultrasonography ☐ Fasting lipid profile	☐ Holter ☐ TCD ☐ Young stroke workup	☐ CTA/MRA ☐ Diabetes screening ☐ Cancer screening

C. DISCHARGE

1	*Treatments prescribed upon discharge (select all that apply)	☐ None	
		☐ *Antiplatelet →	☐ Aspirin (ASA) ☐ Cardiprin ☐ Clopidogrel ☐ Prasugrel ☐ Ticlopidine ☐ Cilostazol ☐ Ticagrelol ☐ Dipyridamole ☐ Other antiplatelet, specify: _____
		☐ *Anticoagulant →	☐ Warfarin ☐ Heparin/low molecular weight heparin ☐ Dabigatran ☐ Rivaroxaban ☐ Apixaban ☐ Edoxaban ☐ Other anticoagulant, specify: _____
		☐ Antidiabetic →	☐ Specify: _____
		☐ Anti-hypertensives →	☐ Specify: _____
		☐ Statin →	☐ Specify: _____
		☐ Other →	☐ Specify: _____
		☐ Unknown	
2	*NIHSS on discharge	__ __	○ Not done
3	*mRS on discharge	○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6	○ Not done
4	*Discharge destination	○ Home ○ Transferred within the same centre ○ Transferred to another centre ○ Social care facility/nursing care ○ Patient died	
5	*Date of discharge / death	__ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*	
6	*Length of hospital stay	__ __ __ days *(Auto-calculated)*	

Version 1.21 (Date: 30/10/2024)

End of Report

Published by:
Clinical Research Centre,
Hospital Sultanah Nur Zahirah

CRC
HOSPITAL SULTANAH NUR ZAHIRAH
Research that matters to patients

eISBN 978-629-94884-1-5