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A Review: Stroke in the Elderly in Thailand: A Comprehensive Review of Epidemiology in Elderly People, Risk Factors, and Prevention

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Abstract:

Stroke was the second leading global cause of death and the third leading cause of disability. Generally, stroke was also increasingly recognized as an essential cause of disability and mortality among both genders. Despite the improvement in the healthcare system, the mortality rate of stroke in Thailand is still highly increasing every year. Extra knowledge of various risk factors contributing to the occurrence of stroke will be beneficial in the operation of regional healthcare services, while also decreasing the social burden rate after post-treatment. Elderly people have higher chance of death caused from stroke and nowadays, number of elderly people has steadily increase.

This literature research provided several risk factors and primary, secondary, and tertiary prevention in both ischemic and hemorrhage strokes. As with the risk factor, we demonstrated comprehensively throughout every health factor, which played an important role in causing stroke in Thai population, categorized in two groups: non-modifiable and modifiable risk factors. To be more precise, non-modifiable risk factors, presented were two factors that are aging and gender, while modifiable risk factors are four factors comprising dyslipidemia and metabolic syndrome, diabetes, smoking, hypertension, and atrial fibrillation. Focusing on primary prevention, it is also composed of two groups: behavioral risk factors and underlying diseases. In behavioral risk factors, there are two behaviors taken into consideration which are salt intake and smoking. Furthermore, in underlying diseases, there were several crucial sicknesses related to hypertension, dyslipidemia, atrial fibrillation, diabetes, and metabolic syndrome. As with secondary and tertiary prevention, the information about preventing each patient, from recurrent stroke events and further complications and disabilities in individuals who have already experienced a stroke, was provided comprehensively.

Keywords **—Stroke, Elderly, Risk Factors,Thailand**

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Background

Stroke is a medical emergency occurring when blood flow to the brain is disrupted, either by a blockage (ischemic stroke) or bleeding (hemorrhagic stroke). This can cause brain cells to die and result in various

symptoms, such as paralysis, speech difficulties, and cognitive impairment. A global systematic analysis of the disease from 1990 to 2019 found an increase of stroke incident by 70.00%, stroke prevalence by 85.00%, deaths from stroke by 43.00%. Finally, the accumulation of years lived with disability as measured by DALYs (disability-adjusted life years) was increased by 32.00%. [1] Likewise, a nationwide cross-sectional study in Thailand also found an increasing trend in stroke patients. Stroke prevalence rates were 4.00%, 3.80%, and 3.90% in 2014, 2015 and 2018, respectively (p=0.221). [2]

Therefore, stroke was increasingly recognized as an essential cause of disability and mortality. It was a leading cause of death and long-term disability in both males and females. Despite the improvement of the healthcare system, the mortality rate of stroke in Thailand was still highly increasing every year. [3,4,5] The average age of Thai patients was 68.78 ± 12.03 of which 44.80% were male. Accounting for 34.30% of stroke patients were aged 75 or older. [2] Moreover, ischemic stroke was a majority type of stroke in Thailand accounted for 90.04% while 9.96% was from transient ischemic attack (TIA). [1]

From various studies, it was repeatedly found that strokes are often caused by individual health conditions and behaviors such as hypertension, diabetes mellitus, smoking, alcohol consumption, hyperlipidemia, etc. [6,7,8,9]. The prevalence of such conditions within Thai elders were estimated to be as follows; hypertension was ranging from 16.70 to 47.20% (criteria over 140/90 mmHg) or 6.10 to 24.80% (criteria over 160/90 mmHg). Smoking and alcohol consumption varied among areas. For example, it was around 19.50% in Sakon Nakhon and 62.10% in Lampang for smoking, and 16.80% in Nakhon Pathom to 33.70% in Lampang for alcohol.

Nowadays, as the number of elders has steadily increased annually [3], Thailand has been making efforts to cope with stroke problems in elders continually. Stroke prevention strategies have been developed to target specific stages of the disease which are grouped into primary, secondary, and tertiary preventions [10]. The primary prevention aims to prevent the occurrence of stroke in individuals who have not yet experienced a stroke. Therefore, this first strategic group usually dealt with giving awareness to elders and their caregivers regarding the disease related to higher risk of stroke (i.e., hypertension [11,12], diabetes [13,14]) and promoting a healthy lifestyle (i.e., no or limiting smoking and alcohol consumption, regular physical activity [11,15]. The secondary prevention aims to prevent recurrent strokes in individuals who have already experienced a stroke. Therefore, in addition to the usual good habits found with the primary group, ensuring that the stroke survivors adhere to prescribed medications and follow rehabilitation regularly are extremely importance [16]. Finally, tertiary prevention focuses on reducing the impact of stroke-related disabilities and improving the quality of life for the survivors. To achieve such goals, strategies usually include rehabilitation services and providing assistive devices to allow independent living [17]. Counselling or offering support groups where patients can socialize and gain better feeling are also very effective methods [18].

In this current review, we aim to provide a better knowledge of the stroke risk factors, complications, preventions, and its outcomes among Thai elders. With better insights, there could be benefits toward building a sustainable and efficient policy for the future which could eventually reduce social burden.

1.0 Stroke Risk Factors

Stroke risk factors can be categorized into two groups: non-modifiable and modifiable factors. In this section, we will discuss some of the most prominent factors from both groups. The first group consisted of aging and gender. The second group consisted of metabolic and cardiovascular related conditions, diabetes, and smoking behavior.

2.1 non-modifiable risks factor

Factor 1: Aging

Thailand has been experiencing demographic changes like many other countries. The proportion of elderly individuals is growing accompanied by a low population growth rate. [3] From a public health viewpoint, age was one of the most significant risk factors for a variety of diseases including stroke. Though stroke can occur at any age, there are usually a more cases in elder populations. The number of stroke cases doubled every decade between the age of 45 to 85 with 70.00% of all stroke cases being above the age of 65. [19] The doubles were found similar in both men and women [20]. Patients aged 75 years and older had 2.50 times higher mortality rates and poorer outcomes than the younger. [21] With these mentioned statistics, age was clearly a significant risk factor for stroke. Thai population data also suggests similar conclusion. A study in 1985 found the prevalence rate for Thai population age over 20 years in Bangkok area to be only at 690 per 100,000. [22] The number increases to 1,120 per 100,000 when surveyed population was scoped to over 60 years. [23]

When people age, there were various physiological changes which lead to poorer health conditions. The part about strokes is usually ones related to the cardiovascular system such as vessel aging conditions. Aged vessels become thickening with gradual loss of elasticity, resulting in vascular stiffness. [24] However, to the point of developing atherosclerosis (underlying cause for various cardiovascular-related complications), aging is not the only factor but rather usually accompany with more traditional risk factors including hypertension, hyperlipidemia, diabetes, smoking, etc. which will be discussed in the following sections.

Factor 2: Gender

There was a difference in the incidence of stroke between males and females. It was well-documented that stroke incidence was higher in males than females. From a Thai epidemiologic study in 2011, male had a higher prevalence than female in all age groups with the overall prevalence ratio of 2.09. [25] The prevalence of stroke in male who aged over 45 years is starting at 1.77 per 100 compared to 0.79 in female counterparts. Then, the older, the higher prevalence in both male and female groups. Finally, the prevalence of male elder aged 75-84 years becomes 3.59 per 100 compared to 2.80 in female. [3] On the other hand, from another research, the age onset of the first stroke among females was greater than among males. Owing to having stroke conditions at a younger age, males were prone to indicate a better functional outcome and had a lower-case fatality rate when compared to females. [26]

Nonetheless, it was important to point out that (without specific to stroke condition), females had more lifespan than males. The gender differential in mortality was due to a twofold elevation of arteriosclerotic heart disease among males because of greater cigarette smoking among males and possibly a protective role of female hormones. The other major causes of males' higher death rates were accidents, suicide, and cirrhosis of the liver due to the behavior accepted more in men in our society, such as using guns, being adventurous and acting unafraid, working at hazardous jobs, and drinking alcohol. [27]

2.2 modifiable risks factor

Factor 3: Dyslipidemia

Dyslipidemia is specially defined as the imbalance of lipids such as cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides, and high-density lipoprotein (HDL) which is known to be a risk factor for atherosclerosis-related ischemic stroke. [28] The imbalance of lipids can be associated with metabolic syndrome, which is a syndrome caused by abnormalities in nutrients and energy because of excess energy (triglyceride, etc.) stored in the multiple organs in the body. Obesity is known to promote cardiovascular diseases. On one hand, adipose tissue hypertrophy around the heart and coronary arteries could affect heart tissue hypertrophy and remodeling which contribute to heart failure. On the other hand, unbalanced

substances in the bloodstream (e.g., triglycerides in ectopic fat, oxidized LDL) will be ingested by macrophages abnormally and transform into the "foam cells." These foam cells can adversely result in early atherosclerosis condition. [29] As such condition is known to related with stroke. A recent study has suggested the use of metabolic markers from bloodstream for early diagnose of ischemic stroke. [30] According to the Thai Stroke Registry, hypercholesterolemia was found in 30.00% of stroke cases. [31] In addition, there was an upward trend of metabolic syndrome among elderly aged over 60 years. [32] Hence, the prevalence of hypercholesterolemia also found to be increased with age from below 10.00% in young adults, to about 25.00% in the elderly particularly the elders' group who live in the seaside area of Thailand [33].

Factor 4: Diabetes

Diabetes is a chronic disease characterized by elevated levels of blood sugar. The prevalence of diabetes was increasing worldwide, particularly among developing countries (69.00% increase compared to 20.00% increase in developed countries). [34] In Thailand, the prevalence of diabetes increased with age with its peak at 60-69 years old population group. [35] Not only that the disease found to be related with stroke occurrence [13,14], but diabetes associated with poorer outcomes after stroke such as increased risk of death, longer hospital stays, increased stroke-related dementia, and other complications including stroke recurrence. [36,37,38] According to Thailand diabetes registry project, the prevalence of stroke among diabetes patients was at 3.50%. and most are patients with Type II diabetes. [39] The disease association with ischemic stroke is more significant than with hemorrhagic stroke. [39,40] Additionally, it is important to point out that diabetes in young adults seems to relate with greater prevalence of stroke than the elders. [14].

The mechanisms in which diabetes becomes a risk factor toward stroke are pathological changes in blood vessels mainly endothelial dysfunction and atherosclerosis condition. [34] Normal blood vessels tend to have anti-atherosclerosis properties by generating and secreting many important substances such as nitric oxide (NO). At the same time, healthy vessels are an effective barrier against some large molecules such as albumin and lipoprotein to limit them entering the circulation. When endothelial dysfunction occurs, those two major functions have been altered resulting in arterial stiffness and vessel inflammation. [41] Additionally, coagulative activation and platelet hyper-reactivity in diabetic patients could contribute to prothrombotic state. [42] As a result of increased tendency of blood clots, blood flow could get obstructed and hence, higher risk of stroke.

Factor 5: Smoking

Cigarette smoking has been suggested as an associated risk factor of stroke for long. According to an extensive review, smoking could increase risk of stroke by two- to fourfold compared to nonsmokers. [43] For Thailand, the national statistics from 2004 to 2021 shows that the smoking rate of Thai population aged 15 years and older has steadily declined from 43.70% to 34.70% for men and from 2.60% to 1.30% for women. Also, most smokers reported smoking daily. The same survey found that young population (15-19 years old) has the lowest smoking rate (6.20%) whereas the working age group (25-44 years old) has the highest rate (21.00%). After that, the smoking rate is lowering with age. The elder group (60 years and over) then becomes the second lowest smoking rate of 12.70%. However, most smokers start smoking around the working age range and if they continue smoking for over a year, it usually becomes a habit. [44] Therefore, the elderly who smoke are likely to have higher exposure years than the younger ones. This could be an underlying reason why smoking seems to be of more relative importance as being a stroke risk for elders when compared with either hypertension or diabetes. [45] The dose-response effect of smoking was also found with the secondhand smokers (SHS). [46] For SHS, the effects from exposure could be immediate. [47,48] Long term exposure to smoking environments (defined as living with a spouse who

smokes > 1 cigarette per day for up to one year) was associated with 10.00% increased risk of deaths from all types of strokes compared to non-exposure groups. [49] In contrast, quitting smoking could affect health condition with both immediate response and long-term health condition. Abstaining from smoking significantly reduced the risk of stroke. [50] Smoking cessation for more than 5 years could reduce the stroke risk by half which is more effective than fat control or high blood pressure. [51] If stop smoking for 15 years, the stroke risk can reduce as much as people who have never smoked. [43]

The elderly smokers in Samut Songkhram province reported smoking on an average of 10 cigarettes per day (half of a cigarette pack). [51] This amount was at the upper bound of the usual Thai smokers (i.e., 75.10% of Thai smokers smoke 1-10 cigarettes/day, 22.70% smoke 11-20 cigarettes/day, and only 2.20% are heavy smokers who smoke more than 20 cigarettes/day). [44] In a Taiwan study, higher risk of all strokes was found with >30 pack-years smokers (POR 1.71) and < 30 pack-years (POR 1.11) when compared to the non-smoker groups (POR 1.00). [52] It is important to point out that to reach 30 pack-years, it requires only 1.5-2 cigarettes/day.

However, elders tended to have a combination of risk factors. The association between elderly smoking and stroke might be somewhat less straightforward and reported as less significant than other risk factors. For example, comparing odd ratio among risk factors for Thai elders (> 60 years old) in Yasothon province, it was found that hyperlipidemia and hypertension are among the highest risks (ORadj 3.00 and 1.70). The less significant factors are gender and smoking (ORadj 1.60 and 1.50). [53] Another study conducted from 1994 to 1996 even concluded that smoking is an insignificant risk factor for stroke in elders. [54]

In terms of potential mechanisms of nicotine toward being a stroke risk factor, there are several underlying reasons. Nicotine reduces red blood flow to the brain, deteriorates the arteries, increases blood thrombosis, and hence there is a high chance of brain stroke. [55] Moreover, it could shrink arteries and increase blood pressure, impair the blood-brain barrier (BBB) permeability, increase reactive oxygen species (ROS) production, and activate proinflammatory pathways. [56] Note that some inflammatory markers were associated with risk of recurrent stroke. [57]

Factor 6: Hypertension

Hypertension is the most common and well-established risk factor for stroke in most studies. For example, a case-control study in 22 countries worldwide reported the highest odd ratio of 2.61 for the history of hypertension compared to other surveyed factors[11] In the Thai Stroke Registry, hypertension condition was found in majority of the cases at 53.00%. [31] Likewise, survey study with 24 stroke clinics across Thailand, has shown that among stroke patients who aged over 45 years hypertension is the most prevalent pre-stroke risk factor (62.50% self-reported of having the condition with average of about 140/80 mmHg in blood pressure). [12] This figure is approximate to the proportion of elders with hypertension. Nationwide surveys in Thailand indicated that over 60.00% of older people are living with hypertension and poorly controlled blood pressure. [58,59,60] Control of hypertension is rather inadequate in Thailand. Even among stroke survivors, only 49.10% of the 558 patients were able to attain recommended blood pressure level 120 days following their stroke. [12] However, stroke management through blood pressure control should be taken seriously in aging patients with hypertension since age factor was found to have dose-response relationship with ischemic stroke in this population (i.e., odd ratio increasing with age using <40 years as baseline). Note that during five years period from 2014 to 2018, the prevalence of stroke among Thai patients with hypertension were considered unchanged and ranged from 3.80% - 4.00% (p for trend = 0.221). [2]

As for factors involved in hypertension-induced stroke, there were several pathogeneses taken together in an intercausal relationship. First, alterations in the structure and blood flow of cerebral blood vessels. Generally, hypertension leads to vascular stiffening. [61] Cerebral blood flow is also reduced because of

increased vascular tone and endothelial dysfunction. [62] Next, hypertension causes oxidative stress and inflammation in blood vessels. [63,64] Baroreflex is also less sensitive to blood pressure change in hypertension individuals. [65] More detailed regarding these mentioned mechanisms are reviewed thoroughly in. [66]

Factor 7: Atrial Fibrillation

Atrial fibrillation (AF) is a cardiac disorder characterized by an abnormal and frequently rapid heart rate. The upper chambers of the heart (atria) beat irregularly and fail to effectively move blood into the ventricles, resulting in blood pooling in the atria and potentially leading to the formation of sluggish blood clots. When a blood clot develops in the left atrium, it can obstruct blood flow through the brain's arteries while traveling to the brain, causing a condition known as stroke.

Strokes triggered by complications from AF are known to be more severe than those caused by other underlying factors. Age was a significant risk factor for AF, and its prevalence increased as individuals advance in age [67,68,69]. The pathophysiology of age-related AF was intricate and involved in a combination of structural and electrical changes at atria. While most ischemic strokes in AF patients were likely cardioembolic, resulting from the migration of thrombi originating from the left atrial appendage, elderly patients might have other potential causes of stroke, such as extracranial or intracranial atherosclerotic stenosis, aortic arch atheroma, or small vessel disease. Studies have shown that AF increased the risk of embolic stroke five times compared to the general population [70]. Moreover, studies have shown that up to 23.70% of stroke patients are eventually diagnosed with AF. [71,72,73].

The occurrence of AF closely linked to age. In studies conducted both in Thailand and internationally, AF prevalence ranges from 0.50% in patients younger than 40 years, 5.00% in patients over 65 years of age, and almost 10.00% among individuals in their eighties. [71,72,73] Thus, AF was a prevalent and significant condition in the elderly. In Thailand, the prevalence of AF among individuals aged over 65 years was found to be 7.20%. [71] It served as a predictive factor for mortality in this population and posed a major risk for stroke [67]. AF related to serious complications espeacially stroke, which remained the leading cause of death and disabilities worldwide [68]. In fact, approximately 15.00% of patients admitted for ischemic stroke had AF, and this proportion increases with age, reaching about 40.00% in individuals over 80 [74].

Notably, AF was not only linked to the overall risk of stroke, but it was most significantly correlated with strokes that exhibit neuroimaging patterns such as cardiac embolism. [75,76] This highlighted the importance of AF-related complications in stroke occurrences, especially in elderly patients, who might have a higher risk of remaining disabled after the event. Evaluation of the absolute risk of stroke in patients with AF was crucial, and various scoring systems have been developed to estimate stroke risk on an individual basis and guide preventive therapy choices. [77] Comprehensive studies focusing on the elderly population are needed to tailor interventions and optimize AF management.

2.0 Stroke Prevention Strategies

As stroke is a major health burden in Thailand, prevention rather than treatment is considered the best policy for stroke management. To achieve an effective management policy, it is essential to identify risk factors and control properly [23]. Corresponding preventive strategies have been grouped into subsequent stages to address different stages of disease development and progression. Combining these preventive stages will not only result in preventing the onset of disease through risk reduction, but also downstream complications of the disease. [78] However, in our review, we will focus only on the prevention methods in the primary, secondary, and tertiary levels to elaborate topics in the scope of preventions that an individual is responsible for him/herself. Therefore, the primordial prevention which focused on social and environmental conditions to prevent disease development at an early age (younger children) and the

quaternary prevention stage which dealt mainly with appropriate treatment of a disease are considered beyond the scope of the current review.

2.1 Primary prevention

Primary prevention focuses on preventing the onset of a disease or condition. It aims to reduce the risk factors that can lead to the development of unwanted disease. Healthy lifestyles which refer to a set of habits and behaviors that promote physical, mental, and emotional well-being are the most effective prevention at this stage. For a normal population, a person has control over many lifestyle choices. Therefore, ensuring awareness among the populations is crucial.

Nutrition is far more important in stroke risk than most physicians suppose. A healthy diet is shown to be the most accountable for cardiovascular health issues. [79] Careful consumption of foods and beverages is the basis of one's healthy condition. Generally, low carbohydrates, a lot of fruits and vegetables, accompanied with regular fish consumption are suggested toward reducing stroke risk. [11,80,81,82] Plant-derived omega-3 polyunsaturated fatty acids acquired from vegetable oils is also a good option. [83] However, the amount of salt intake reserves particular attention as high salt intake leads to high blood pressure. [84] Reduction in the amount of salt intake is found to effectively reduce both systolic and diastolic blood pressures in normal populations and even more in hypertension patients. [85,86] Clear evidence suggested that higher salt intake is associated with 20% of all intracerebral hemorrhages. [87] The international recommendations suggest that sodium intake should be less than 5-6 g per day, while the average intake is more than 6 g or even over 12 g in many countries. [88] Moreover, because of imprecision in measurement of salt intake, the effect sizes of many studies are prone to be underestimated. [89]

Never starting, quitting, or limiting smoking is also an effective strategy to prevent stroke. The 2021 Guidelines from the American Heart Association/American Stroke Association clearly recommends that patients who smoke be advised to quit smoking as part of stroke prevention efforts [90]. As mentioned in the risk factors section, the effect of smoking is in dose-response relationship which means that the less amount of smoking, the better in stroke prevention. It was estimated that smoking as little as 1 cigarette per day is associated with an approximately 25% to 30% increased risk of stroke. [91] Looking at Thailand situation, 21.5% of Thai high school students reporting current tobacco use [92]. This is not a good sign toward a healthy lifestyle even though several initiatives have been implemented in Thailand to reduce tobacco use; including the Tobacco Control Act, which prohibits smoking in public places and requires graphic health warnings on cigarette packaging.

Regular physical activity and maintaining a healthy weight are certainly encouraged. According to INTEERSTROKE study, physical inactivity is a key risk factor with the odd ratio of 0.69 [11] Adopting regular physical activity is benefits in preventing hypertension development at all ages ranging from 35-74 years. [93] There also various positive alterations such as improving endothelial function, reducing left ventricular hypertrophy, control level of HDL/LDL cholesterols, and more. [94] Physical activity guidelines estimated the reduction of 25-30% in stroke risk due to appropriate physical activity. [95] However, within the scope of being primary prevention of stroke, there are issues which remain unsettled including gender-dependent difference as well as level of exercise intensities and its duration. [94] Traditionally, to reduce cardiovascular risk, moderate to vigorous aerobic physical activity for at least 40 minutes should be done at least 3-4 days per week. [96]

2.2 Secondary prevention

Secondary prevention refers to the treatment of individuals who have already had a stroke or transient ischemic attack (TIA) to prevent the recurrent of stroke event, the more likely to be fatal or disabling than the first episodes. [97] Without any treatment, the risk of recurrent stroke is increased with longer period

after the first episode starting from about 10%-18% within the first three months [98] to about 25% at five years and 40% at ten years [99]. As for Thailand's stroke treatment, most ischemic patients are given aspirin within 48 hours, admitted to acute stroke unit, and given thrombolytic therapy in 71.1%, 24.6%, and 3.8%, respectively. [31] Thai Stroke Guidelines recommended given acute stroke patients with intravenous thrombolysis with recombinant tissue plasminogen activator. [100] Stroke care in Thailand results in 26.1% well recovery patients whereas 3.2% of patients died during hospital care. Very few patients remain in nursing care facilities. [31] Due to the influence of Thai culture, families where large extended families provide care for ailing family members. [100] After a stroke attack and receiving treatment during acute period, it is crucial to keep control of any vascular risk factors within recommended levels to prevent stroke recurrence. To achieve this goal, the use of medication is usually introduced.

Hypertension

The most promising factor is high blood pressure. [89] The effect of blood pressure lowering for secondary stroke prevention is consistent in many studies, irrespective of previous hypertension and across most subtypes of stroke. [101] The optimal target blood pressure is around 130 mmHg systolic and 80 mmHg diastolic for secondary stroke prevention [102]. Antihypertensive drugs and therapy after the acute phase of a stroke are strong consideration for secondary stroke prevention. [103] It is recommended to treat all patients with blood pressure >140/90 mmHg with any choices or combination of the antihypertensive drugs. [89] However, extremely low blood pressure may increase the risk of stroke (inadequate blood flow to the brain especially for older patients) following the J-curve effect. [104]

Dyslipidemia

Controlling cholesterol levels to prevent recurrent ischemic stroke is not as strong as the association with the risk of myocardial infarction (MI) or heart attack. [101] Lowering LDL by about 1 mmol/l is found to reduce the risk of recurrent stroke by at least 12%. [105] Target level for the LDL is range around 70 to 100 mg/dl by statin prescription. [101] In very-high-risk patients, the goal of LDL < 55mg/dl is further recommended. [106] However, side effects of statin therapy are more likely to occur in elderly patients including diabetes mellitus, myophathy, and rhabdomyolysis, hepatotoxicity. [107] Hemorrhagic stroke was also found to be another possible side effect. [108] High doses of statins should be carefully considered with the pros and cons. [107] In Thailand, up to 73% of stroke patients received statin on hospital discharge. [100]

Diabetes

Effect of intense control of hyperglycemia on macrovascular complications such as stroke is not clear. [109] A study with advanced type II diabetes patients, such control even increases mortality rate. [110] On the contrary, controlling both blood pressure and cholesterol levels are of utmost importance in persons with diabetes. [111] Medications such as antihypertensives, antiplatelets, and statins are suggested to manage diabetes and prevent stroke for diabetes patients. [112,113] Additionally, conventional therapy such as dietary restriction should be considered for glucose control.

Atrial Fibrillation

Prevention of stroke in patients with AFib involves various strategies, including anticoagulation therapy, rate control, and rhythm control. Anticoagulation therapy is the most effective way to prevent stroke in patients with AFib, and the use of non-vitamin K antagonist oral anticoagulants (NOACs) has become more widespread in recent years due to their safety and efficacy compared to traditional warfarin therapy [114]. The optimal international normalized ratio range for oral anticoagulation with vitamin K antagonists is between 2.0 and 3.0. [115] Though anticoagulation could affect bleeding risk, the benefits toward stroke

risk reduction are outweigh by far for older patients. [89] Rate control and rhythm control are also important in the management of AFib [116], as they can improve symptoms and reduce the risk of heart failure. Lifestyle modifications, such as avoiding triggers of AFib, managing underlying conditions such as hypertension and diabetes, and maintaining a healthy weight, are also important in preventing AFib and its associated complications.

3.3 Tertiary Prevention

Tertiary prevention refers to strategies that aim to prevent further complications and disabilities in stroke survivors. Helping patients manage their illnesses and enhance their quality of life is the main objective of tertiary prevention. Rehabilitative therapies including physical therapy, occupational therapy, and speech therapy are just a few of the preventions that stroke survivors may benefit from. Rehabilitation can assist people in regaining lost skills and discovering new routines for carrying out daily tasks [17]. It is recommended that stroke survivors should perform strength training, flexible training, incorporate with balance and coordination training. Carried out trainings for 2-3 times per week are also suggested. [94]

Modifications to one's way of life can hopefully minimize the effect of stroke condition. A healthy lifestyle similar to the primary prevention methods can help lower the risk of strokes in the future. Exercise can be difficult due to the survivor's disability conditions. It was found that stroke survivors with mild disability spent most of their time in very light intensity activities [117]. These facts highlight the importance for physical activity interventions to encourage stroke survivors to be more active.

Additionally, those who have had the disease should adopt routine check-ups. Although stroke survivors' longevity is seen as a long-term, frequently complex health problem, a healthcare professional can assist in monitoring the stroke survivor's status and identifying any new or recurring health issues to lessen their ongoing symptoms [118]. However, it is important to note that tertiary prevention strategies may vary depending on the individual's particular necessity and the severity of their stroke. There are plenty of healthcare providers who can provide guidance on the most appropriate strategies for each individual.

4.0 Conclusion

In conclusion, risk factors can be split into two main groups: non-modifiable and modifiable factors. The number of stroke cases that impact people over the age of 65 is up to 70% for both men and women and tends to rise when entering aging society by 2050 making aging become the most significant non-modifying factor. Before the age of 80, gender is another variable that affects the risk of stroke. Males are more likely to experience a stroke than females, and then females are more likely to experience it after the age of 80. The group of modifiable risks factor contains Dyslipidemia, Diabetes, Smoking, Hypertension, and Atrial Fibrillation.

Prevention strategies are categorized into 3 main stages including primary prevention, secondary prevention and tertiary prevention. Primary prevention strategies should focus on healthy lifestyles such as salt intake, eating more fruits and vegetables, quitting smoking, and regular physical activity. Secondary prevention is the treatment for those who have already had a stroke or transient ischemic attack. Thailand has standard guidelines for stroke cases known as stroke fast track program. The system is designed to allow fast identification of risky patients which lead to proactive measures by the stroke team. Then, to prevent stroke recurrence, the most effective treatment is to manage underlying diseases like hypertension, dyslipidemia, diabetes, and atrial fibrillation. Tertiary prevention has the goal of improving patients' quality of life and managing their illness through modified behaviors, routine check-ups, and receiving healthcare professional services such as rehabilitation therapy.

REFERENCES

[1] Feigin VL, Nguyen G, Cercy K, Johnson CO, Alam T, Parmar PG, et al. Global, regional, and country-specific burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet Neurology [Internet]. 2020 [cite 2023 Aug 1]; 19(3): 255-282. Available from: https://www.thelancet.com/journals/laneur/article/PIIS1474-4422(21)00252-0/fulltext#%20

[2] Chantkran W, Chaissakul J, Rangsin R, Mungthin M, Sakboonyarat B. Prevelence of a and factors associated with stroke in hypertensive patients in Thailand from 2014 to 2018: a nationwide cross-sectional study. Sci Rep [Internet]. 2021[cite 2023 Aug 1]; 11(1): 17614. Available from: https://pubmed.ncbi.nlm.nih.gov/34475463/

[3] Prasertwitayakij N, Kantachuvessiri A. Stroke epidemiology in Thailand. J Stroke Cerebrovasc Dis. 2014; 23(11): 2535-2544.

[4] Tatsanavivat P, Phanthumchinda K, Tiamkao S, et al. Thailand stroke registry: report of the first phase of the registry (2004-2007). J Med Assoc Thai. 2011. 94 Suppl 3: S75-81.

[5] Vatanasapt P, Thamprasert K, Janwantanakul P, et al. A community-based study of prevalence and correlates of stroke in the central region of Thailand. J Med Assoc Thai. 2012; 95 Suppl 2: S269-76.

[6] Tantirittisak T, et al. Risk factors of stroke in the Thai elderly: a population-based case-control study. Journal of the Medical Association of Thailand. 2001; 84(1): 81-88.

[7] Sukhonthasarn A, et al. Prevalence of hypertension and associated factors in Thai Buddhist monks. Journal of the Medical Association of Thailand. 2009; 92(7): 892-898.

[8] Pongchaiyakul C, et al. Prevalence of cardiovascular risk factors in Thai Buddhist monks. Journal of the Medical Association of Thailand. 2007; 90(9): 1860-1864.

[9] Jiamjarasrangsi W, et al. Prevalence of carotid bruit, cardiac murmur, and cardiac arrhythmia in a Thai elderly population. Journal of the Medical Association of Thailand. 2004; 87(8): 854-858.

[10] Kochsawat W. Narrow the gaps in stroke prevention; nursing on the move [PowerPoint slides presented at Siriraj Stroke Conference 2019, 31 May 2019][Internet]. 2019 [cite 2023 Aug 1]. Available from: https://www.sirirajstrokecenter.org/2019/3313.html .

[11] O'Donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countires (the INTERSTROKE study): a case-control study. Lancet [Internet]. 2010 [cite 2023 Aug 1]; 376(9735): 112-23. Available from: https://pubmed.ncbi.nlm.nih.gov/20561675/

[12] Nidhinandana S, Ratanakorn D, Charnnarong N, Muengtaweepongsa S, Towanabut S. Blood pressure control among stroke patients in Thailand-The i-STROKE study. J Stroke Cerebrovasc Dis [Internet]. 2014[cite 2023 Aug 1]; 23(3): 476-483. Available from: https://pubmed.ncbi.nlm.nih.gov/23800493/

[13] American Diabetes Association. Standards of medical care in diabetes - 2021. Diabetes Care [Internet]. 2021[cite 2023 Aug 1]; 44(Suppl 1): S15-S33. Available from: https://pubmed.ncbi.nlm.nih.gov/33298413/

[14] Khoury JC, Kleindorfer D, Alwell K, Moomaw CJ, Woo D, Adeoye O, et al. Diabetes mellitus: a risk factor for ischemic stroke in a large biracial population. Stroke [Internet]. 2013 [cite 2023 Aug 1]; 44(6): 1500-1504. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3746032/

[15] Tai WA. Stroke: primary prevention. FP Essent [Internet]. 2022 [cite 2023 Aug 1]; 512: 11-17. Available from: https://pubmed.ncbi.nlm.nih.gov/35006660/

[16] Tepsuwan J. Recurrent prevention for stroke survivors. The 10th NPRU National Academic Conference. 2018 March 29-30; Nakhon Pathom Rajabhat University. Nakhon Pathom. Nakhon Pathom Rajabhat University; 2018. p.2028-2035.

[17] Mendis S. Prevention and care of stroke in low- and middle-income countries; the need for a public health perspective. International Journal of Stroke [Internet]. 2010 [cite 2023 Aug 1]; 5(2): 86-91. Available from: https://pubmed.ncbi.nlm.nih.gov/20446942/

[18] Oikarinen A, Kaariainen M, and Kyngas H. A framework of counseling for patients with stroke in nursing a narrative literature review. J NeurosciNurs [Internet]. 2014 [cite 2023 Aug 1]; 46(5): E3-E14. Available from: https://pubmed.ncbi.nlm.nih.gov/25188689/

[19] Kelly-Hayes M. Influence of age and health behaviors on stroke risk: lessons from longitudinal studies. J Am Geriatr Soc [Internet]. 2010 [cite 2023 Aug 1]; 58(Suppl 2): S325-S328. Available from: https://pubmed.ncbi.nlm.nih.gov/21029062/

[20] Miah MNA, Azhar MA, Rahman A, Halder D, Akteruzzaman M, Kundu NC. Risk factors of stroke in young and old age group - a comparative study. Journal of Medicine [Internet]. 2012 [cite 2023 Aug 1]; 13(2): 138-142. Available from: https://banglajol.info/index.php/JOM/article/view/12741

[21] Altieri M. SPASE-I: a multicenter observational study on pharmacological treatment of acute stroke in the elderly. The Italian study of pharmacological treatment of acute stroke in the elderly group. Neurol Sci [Internet]. 2002 [cite 2023 Aug 1]; 23: 23–8. Available from: https://pubmed.ncbi.nlm.nih.gov/12111617/

[22] Viriyavejakul A, Pongvarin N, Vannasaeng S. The prevalence of stroke in urban community of Thailand. J Neurol [Internet]. 1985 [cite 2023 Aug 1]; 232(Supply 1): 93. Available from: https://link.springer.com/article/10.1007/BF02428072

[23] Viriyavejakul A, Senanarong V, Prayoonwiwat N, Praditsuwan R, Chaisevikul R, Poungvarin N. Epidemiology of stroke in the elderly in Thailand. J Med Assoc Thai [Internet]. 1998 [cite 2023 Aug 1]; 81(7): 497–505. Available from: https://pubmed.ncbi.nlm.nih.gov/9676086/

[24] Bolton E, Rajkumar C. The ageing cardiovascular system. Rev Clinical Gerontol [Internet]. 2011 [cite 2023 Aug 1]; 21(2): 99–109. Available from: https://www.cambridge.org/core/journals/reviews-in-clinical-gerontology/article/abs/ageing-cardiovascular-system/3F2019465AB354058FF070003C9923D5#

[25] Hanchaiphiboolkul S, Poungvarin N, Nidhinandana S, Suwanwela NC, Puthkhao P, Towanabut S, et al. Prevalence of stroke and stroke risk factors in Thailand: Thai Epidemiologic Stroke (TES) Study. J Med Assoc Thai [Internet]. 2011 [cite 2023 Aug 1]; 94(4): 427–436. Available from: https://www.thaiscience.info/journals/Article/JMAT/10744093.pdf

[26] Wyller TB. Stroke and gender. J GendSpecif Med [Internet]. 1999 [cite 2023 Aug 1]; 2(3): 41-45. Available from: https://pubmed.ncbi.nlm.nih.gov/11252851/

[27] Waldron I, Johnston S. Why do women live longer than men? . Journal of Human Stress [Internet]. 1976 [cite 2023 Aug 1]; 2(2): 19-30. Available from: https://pubmed.ncbi.nlm.nih.gov/1018115/

[28] Huang WY, Chen C, Meng L, Weng WC, Peng T. The influence of anemia on clinical presentation and outcome of patients with first-ever atherosclerosis-related ischemic stroke. Journal of Clinical Neuroscience [Internet]. 2009 [cite 2023 Aug 1]; 16(5): 645-649. Available from: https://pubmed.ncbi.nlm.nih.gov/19285409/

[29] Jin X, Qiu T, Li L, Yu R, Chen X, Li C, Proud CG, Jiang T. Pathophysiology of obesity and its associated diseases. Acta Pharm Sin B [Internet]. 2023 [cite 2023 Aug 1]; 13(6): 2403-2424. Available from: https://pubmed.ncbi.nlm.nih.gov/37425065/

[30] Zhou W, Li S, Sun G, Song L, Feng W, Li R, et al. Early warning of ischemic stroke based on atherosclerosis index combined with serum markers. The Journal of Clinical Endocrinology and Metabolism [Internet]. 2022 [cite 2023 Aug 1]; 107(7): 1956-1964. Available from: https://pubmed.ncbi.nlm.nih.gov/35349673/

[31] Nilanont Y, Nidhinandana S, Suwanwela NC, Hanchaiphiboolkul S, Pimpak T, Tatsanavivat P, et al. Quality of acute ischemic stroke care in Thailand: a prospective multicenter countrywide cohort study. J Stroke Cerebrovasc [Internet]. 2014[cite 2023 Aug 1]; 23(2): 213-9. Available from: https://pubmed.ncbi.nlm.nih.gov/23305673/
[32] Lalam, P, Chaimai, A, Fukfon, K. Metabolic syndrome in older persons: impacts and nursing roles. Journal of Nursing and Health Research [Internet]. 2022 [cite 2023 Aug 1]; 23(2): 13-27. (in Thai). Available from: https://he01.tci-thaijo.org/index.php/bcnpy/article/view/258246/174183
[33] Yamwong, P, Assantachai, P and Amornrat, A. Prevalence of dyslipidemia in the elderly in rural areas of Thailand. Southeast Asian J Trop Med Public Health [Internet]. 2000 [cite 2023 Aug 1]; 31(1): 158-162. Available from: https://www.tm.mahidol.ac.th/seameo/2000_31_1/32-2407.pdf
[34] Chen R, Ovbiagele B, Feng W. Diabetes and Stroke: Epidemiology, Pathophysiology, Pharmaceuticals and Outcomes. Am J Med Sci [Internet]. 2016 [cite 2023 Aug 1]; 351(4): 380-386. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5298897/
[35] Aekplakorn W, Tantayotai V, Numsangkul S, Chongsuwat R, Lim SS, Tanjasiri SP. Prevalence of diabetes and relationship with socioeconomic status in the Thai elderly population: national health examination survey III. Journal of Diabetes Research and Clinical Metabolism [Internet]. 2017 [cite 2023 Aug 1]; 6(1): 9. Available from: https://pubmed.ncbi.nlm.nih.gov/29687009/
[36] Snarska KK, Bachórzewska-Gajewska H, Kapica-Topczewska K, Drozdowski W, Chorąży M, Kułakowska A, et al. Hyperglycemia and diabetes have different impacts on outcome of ischemic and hemorrhagic stroke. Arch Med Sci [Internet]. 2017 [cite 2023 Aug 1]; 13(1): 100–108. Available from: https://pubmed.ncbi.nlm.nih.gov/28144261/
[37] Szlachetka WA, Pana TA, Tiamkao S, Clark AB, Kongbunkiat K, Sawanyawisuth K, et al. Impact of diabetes on complications, long term mortality and recurrence in 608,890 hospitalized patients with stroke. Glob Heart [Internet]. 2020[cite 2023 Aug 1]; 15(1): 2. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7218766/
[38] Roquer J, Giralt-Steinhauer E, Cerdà G, et al. Glycated hemoglobin value combined with initial glucose levels for evaluating mortality risk in patients with ischemic stroke. Cerebrovasc Dis [Internet]. 2015 [cite 2023 Aug 1]; 40: 244-50. Available from: https://pubmed.ncbi.nlm.nih.gov/26484656/
[39] Plengvidhya N, Leelawatana R, Pratipanawatr T, Deerochanawong C, Krittiyawong S, Bunnag P, et al. Thailand diabetes registry project: prevalence and risk factors of stroke in Thai diabetic patients. J Med Assoc Thai [Internet]. 2006 [cite 2023 Aug 1]; 89 (Suppl 1): S49-53. Available from: https://pubmed.ncbi.nlm.nih.gov/17715834/
[40] Mankovsky BN, Ziegler D. Stroke in patients with diabetes mellitus. Diabetes Metab Res Rev [Internet]. 2004 [cite 2023 Aug 1]; 20(4): 268-87. Available from: https://pubmed.ncbi.nlm.nih.gov/15250030/
[41] Malakul W. Vascular endotherlium in diabetes mellitus. Naresuan University Journal [Internet]. 2011[cite 2023 Aug 1]; 19(1): 81-88. [in Thai]. Available from: https://www.journal.nu.ac.th/NUJST/article/view/65
[42] Vazzana N, Ranalli P, Cuccurullo C, Davi G. Diabetes mellitus and thrombosis. Thromb Res [Internet]. 2012 [cite 2023 Aug 1]; 129(3): 371-7. Available from: https://pubmed.ncbi.nlm.nih.gov/22197180/
[43] Shah RS, Cole JW. Smoking and stroke: the more you smoke the more you stroke. Expert Rev CardiovasTher [Internet]. 2010 [cite 2023 Aug 1]; 8(7): 917-32. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2928253/
[44] National Statistical Office [Internet]. Bangkok: National Statistical Office: 2021. The 2021 Health Behavior of Population Survey; 2021[cite 2023 Aug 1]. Available from: http://www.nso.go.th/sites/2014en/Pages/survey/Social/Health/The-2020-Health-behavior-population-survey.aspx
[45] Howard G, Banach M, Kissela B, Cushman M, Muntner P, Judd SE, et al. Age-related differences in the role of risk factors for ischmeic stroke. Neurology [Internet]. 2023[cite 2023 Aug 1]; 100(14): e1444-e1453. Available from: https://pubmed.ncbi.nlm.nih.gov/36653179
[46] Malek AM, Cushman M, Lackland DT, Howard G, McClure LA. Secondhand smoke exposure and stroke: the reasons for geographic and racial differences in stroke (REGARDS) study. Am J Prev Med [Internet]. 2015[cite 2023 Aug 1]; 49(6): 89-97. Available from: https://pubmed.ncbi.nlm.nih.gov/26117341/
[47] Centers for Disease Control and Prevention [Internet]. Georgia: Centers for Disease Control and Prevention: 2022. Smoking & Tobacco Use, Health Problems: 2022 [cite 2023 Aug 1]. Available from: https://www.cdc.gov/tobacco/secondhand-smoke/health.html#print
[48] Flouris AD, Koutedakis Y. Immediate and short-term consequences of secondhand smoke exposure on the respiratory system. CurrOpinPulm Med [Internet]. 2011[cite 2023 Aug 1]; 17(2): 110-115. Available from: https://pubmed.ncbi.nlm.nih.gov/21178628/
[49] Hou L, Han W, Jiang J, Liu B, Wu Y, Zou X, et al. Passive smoking and stroke in men and Women: a National Population-based Case-control Study in China. Sci. Rep [Internet]. 2017[cite 2023 Aug 1]; 7: 45542. Available from: https://pubmed.ncbi.nlm.nih.gov/28361935/
[50] Higa M, Davanipour Z. Smoking and stroke. Neuroepidemiology [Internet]. 1991[cite 2023 Aug 1]; 10(4): 211-22. Available from: https://karger.com/ned/article-abstract/10/4/211/209565/Smoking-and-Stroke?redirectedFrom=fulltext
[51] Ruamsook T, Tipwong A, Vorasiha P, Wongsawang N, Lumrod N. Health literacy of knowledge and the understanding of tobacco and smoking behavior among older persons: A case study in Amphawa District, Samut Songkhram Province. Journal of Health Science Research [Internet]. 2021[cite 2023 Aug 1]; 15(1): 131-140. Available from: https://he01.tci-thaijo.org/index.php/JHR/article/view/240974/168821
[52] Lee TK, Huang ZS, Ng SK, Chan KW, Wang YS, Liu HW, et al. Impact of alcohol consumption and cigarette smoking on strong among the elderly in Taiwan. Stroke [Internet]. 1995 [cite 2023 Aug 1]; 26(5): 790-794. Available from: https://pubmed.ncbi.nlm.nih.gov/7740568/
[53] Namwong T, Arrirak N. Prevalence and factors associated with stroke among the elderly in Yasothon province. Dis Control J [Internet]. 2023 [cite 2023 Aug 1]; 49(1): 149-157. [in Thai]. Available from: https://he01.tci-thaijo.org/index.php/DCJ/article/view/254129/176813
[54] Viriyavejakul A, Senanarong V, Prayoonwiwat N, Praditsuwan R, Chaisevikul R, Poungvarin N. Epidemiology of stroke in the elderly in Thailand. J Med Assoc Thai [Internet]. 1998 [cite 2023 Aug 1]; 81(7): 497-505. Available from: https://pubmed.ncbi.nlm.nih.gov/9676086/
[55] Pattapat W. Nursing care of elderly stroke patients in the recovery phase: a case study. Thai Red Cross Nursing Journal [Internet]. 2020 [cite 2023 Aug 1]; 14(2): 37-49. Available from: https://he02.tci-thaijo.org/index.php/trcnj/article/view/256569
[56] Lowe GDO. Circulating inflammatory markers and risks of cardiovascular and non-cardiovascular disease. J ThrombHaemost [Internet]. 2005[cite 2023 Aug 1]; 3: 1618–1627. Available from: https://pubmed.ncbi.nlm.nih.gov/16102027/
[57] Welsh P, Lowe GDO, Chalmers J, Campbell DJ, Rumley A, Neal BC, et al. Associations of proinflammatory cytokines with the risk of recurrent stroke. Stroke [Internet]. 2008[cite 2023 Aug 1]; 39(8): 2226-2230. Available from: https://pubmed.ncbi.nlm.nih.gov/18566306
[58] Meelab S, Bunupuradah I, Suttiruang J, Sakulrojanawong S, Thongkua N, Chantawiboonchai C, et al. Prevalence and associated factors of uncontrolled blood pressure among hypertensive patients in the rural communities in the central areas in Thailand: A cross-sectional study. PloS one [Internet]. 2019 [cite 2023 Aug 1]; 14(2): e0212572–e0212572. Available from: https://pubmed.ncbi.nlm.nih.gov/30779818/
[59] Sakboonyarat B, Rangsin R, Kantiwong A, Mungthin M. Prevalence and associated factors of uncontrolled hypertension among hypertensive patients: A nation-wide survey in Thailand. BMC Research Notes [Internet]. 2019 [cite 2023 Aug 1]; 12(1), 380. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6610935/
[60] Woodham N, Taneepanichskul S, Somrongthong R, Auamkul N. Medication adherence and associated factors among elderly hypertension patients with uncontrolled blood pressure in rural area, northeast Thailand. Journal of Health Research [Internet]. 2018 [cite 2023 Aug 1]; 32(6): 449–458. Available from: https://www.emerald.com/insight/content/doi/10.1108/JHR-11-2018-085/full/html

[61] Baumbach GL, Heistad DD. Cerebral circulation in chronic arterial hypertension. Hypertension [Internet]. 1988 [cite 2023 Aug 1]; 12: 89–95. Available from: https://pubmed.ncbi.nlm.nih.gov/3044994/
[62] Barry DI. Cerebral blood flow in hypertension. J Cardiovasc Pharmacol [Internet]. 1985 [cite 2023 Aug 1]; 7(Suppl 2): S94–S98. Available from: https://pubmed.ncbi.nlm.nih.gov/2409378/
[63] Vaziri ND, Dicus M, Ho ND, Boroujerdi‐Rad L, Sindhu RK. Oxidative stress and dysregulation of superoxide dismutase and NADPH oxidase in renal insufficiency. Kidney Int [Internet]. 2003 [cite 2023 Aug 1]; 63: 179‐185. Available from: https://pubmed.ncbi.nlm.nih.gov/12472781/
[64] Nava M, Quiroz Y, Vaziri N, Rodriguez‐Iturbe B. Melatonin reduces renal interstitial inflammation and improves hypertension in spontaneously hypertensive rats. Am J Physiol Renal Physiol [Internet]. 2003[cite 2023 Aug 1]; 284: F447‐F454. Available from: https://pubmed.ncbi.nlm.nih.gov/12441307/
[65] Bristow JD, Honour AJ, Pickering GW, Sleight P, Smyth HS. Diminished baroreflex sensitivity in high blood pressure. Circulation [Internet]. 1969 [cite 2023 Aug 1]; 39(1): 48–54. Available from: https://pubmed.ncbi.nlm.nih.gov/4302539/
[66] Yu JG, Zhou RR, Cai GJ. From hypertension to stroke: mechanisms and potential prevention strategies. CNS NeurosciTher [Internet]. 2011 [cite 2023 Aug 1]; 17(5): 577-584. Available from: https://pubmed.ncbi.nlm.nih.gov/21951373/
[67] Hindricks G, Potpara T, Dagres N, Arbelo E, Bax JJ, Blomström-Lundqvist C, et al. 2020 ESC Guidelines for the Diagnosis and Management of Atrial Fibrillation Developed in Collaboration With the European Association of Cardio-Thoracic Surgery (EACTS): The Task Force for the Diagnosis and Management of Atrial Fibrillation of the European Society of Cardiology (ESC) Developed With the Special Contribution of the European Heart Rhythm Association (EHRA) of the ESC. Eur Heart J [Internet]. 2021 [cite 2023 Aug 1]; 42(5): 373-498. Available from: https://pubmed.ncbi.nlm.nih.gov/32860505/
[68] European Society of Cardiology (2020). 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS). European Heart Journal [Internet]. 2020 [cite 2023 Aug 1]; 00: 1-125. Available from: https://www.escardio.org/static-file/Escardio/Guidelines/Documents/ehaa612.pdf
[69] Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, Casadei B, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. European Heart Journal [Internet]. 2016 [cite 2023 Aug 1]; 37(38): 2893-2962. Available from: https://pubmed.ncbi.nlm.nih.gov/27663299/
[70] Maier IL, Schregel K, Karch A, Weber-Krueger M, Mikolajczyk RT, et al. Association between Embolic Stroke Patterns, ESUS Etiology, and New Diagnosis of Atrial Fibrillation: A Secondary Data Analysis of the Find-AF Trial. Stroke Research and Treatment [Internet]. 2017[cite 2023 Aug 1]; 1391843. Available from: https://pubmed.ncbi.nlm.nih.gov/28536667/
[71] Phrommintikul A, Detnuntarat P, Prasertwitayakij N, Wongcharoen W. Prevalence of atrial fibrillation in Thai elderly. J GeriatrCardiol [Internet]. 2016 [cite 2023 Aug 1]; 13(3): 270-3. Available from: https://pubmed.ncbi.nlm.nih.gov/27103924/
[72] Kalman JM, Tonkin AM. Atrial fibrillation: epidemiology and the risk and prevention of stroke. Pacing Clin Electrophysiol [Internet]. 1992 [cite 2023 Aug 1]; 15(9): 1332-46. Available from: https://pubmed.ncbi.nlm.nih.gov/1383992/
[73] Son MK, Lim N, Kim HW, Park H. Risk of ischemic stroke after atrial fibrillation diagnosis: A retrospective cohort study. PLoS One [Internet]. 2017[cite 2023 Aug 1]; 12(6): e0179687. Available from: https://pubmed.ncbi.nlm.nih.gov/28636620/
[74] Hijazi Z, Lindback J, Alesander JH, Hanna M, Held C, Hylek EM, et al. ABC (age, biomarkers, clinical history) stroke risk score: a biomarker-based risk score for predicting stroke in atrial fibrillation. European Heart Journal [Internet]. 2016 [cite 2023 Aug 1]; 7(20): 1582-90. Available from: https://pubmed.ncbi.nlm.nih.gov/26920728/
[75] Migdady I, Russman A, Buletko AB. Atrial Fibrillation and Ischemic Stroke: A Clinical Review. Semin Neurol [Internet]. 2021[cite 2023 Aug 1]; 41(4): 348-364. Available from: https://pubmed.ncbi.nlm.nih.gov/33851396/
[76] Essa H, Hill AM, Lip GYH. Atrial Fibrillation and Stroke. Card Electrophysiol Clin [Internet]. 2021 [cite 2023 Aug 1]; 13(1): 243-255. Available from: https://pubmed.ncbi.nlm.nih.gov/33516402/
[77] Ryan SS. A-Fib.com [Internet]. California: A-Fib, Inc.: c2001-2023. The CHADS2 and CHA2DS-VASc Stroke-risk grading systems; 2014 [cite 2023 Aug 1]. Available from: https://a-fib.com/the-chad2-stroke-risk-grading-system/
[78] Kisling LA, Das JM. Prevention Strategies. In; StatPearls [Internet]. Florida: StatPearls Publishing: 2023 [cite 2023 Aug 1]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK430685/
[79] Spence JD. Nutrition and risk of stroke. Nutrients [Internet]. 2019 [cite 2023 Aug 1]; 11(3): 647. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6470893/
[80] Oba S, Nagata C, Nakamura K, Fujii K, Kawachi T, Takatsuka N, et al. Dietary glycemic index, glycemic load, and intake of carbohydrate and rice in relation to risk of mortality from stroke and its subtypes in Japanese men and women. Metabolism [Internet]. 2010 [cite 2023 Aug 1]; 59: 1574– 1582. Available from: https://pubmed.ncbi.nlm.nih.gov/20303126/
[81] He FJ, Nowson CA, MacGregor GA. Fruit and vegetable consumption and stroke: metaanalysis of cohort studies. Lancet [Internet]. 2006 [cite 2023 Aug 1]; 367: 320–326. Available from: https://pubmed.ncbi.nlm.nih.gov/16443039/
[82] Larsson SC, Orsini N. Fish consumption and the risk of stroke: a dose-response meta-analysis. Stroke [Internet]. 2011 [cite 2023 Aug 1]; 42: 3621–3623. Available from: https://pubmed.ncbi.nlm.nih.gov/21903950/
[83] de Goede J, Verschuren WM, Boer JM, Kromhout D, Geleijnse JM. Alpha-linolenic acid intake and 10-year incidence of coronary heart disease and stroke in 20,000 middle-aged men and women in the Netherlands. PLoS One [Internet]. 2011 [cite 2023 Aug 1]; 6: e17967. Available from: https://pubmed.ncbi.nlm.nih.gov/21464993/
[84] Frohlich ED. The salt conundrum: a hypothesis. Hypertension [Internet]. 2007 [cite 2023 Aug 1]; 50: 161–166. Available from: https://pubmed.ncbi.nlm.nih.gov/17470717/
[85] He FJ, MacGregor GA. Effect of modest salt reduction on blood pressure: a meta-analysis of randomized trials. Implications for public health. J Hum Hypertens [Internet]. 2002 [cite 2023 Aug 1]; 16: 761–770. Available from: https://pubmed.ncbi.nlm.nih.gov/12444537/
[86] Pimenta E, Gaddam KK, Oparil S, Aban I, Husain S, Dell'Italia LJ, et al. Effects of dietary sodium reduction on blood pressure in subjects with resistant hypertension: results from a randomized trial. Hypertension [Internet]. 2009 [cite 2023 Aug 1]; 54: 475–481. Available from: https://pubmed.ncbi.nlm.nih.gov/19620517/
[87] Jamrozik K, Broadhurst RJ, Anderson CS, Stewart-Wynne EG. The role of lifestyle factors in the etiology of stroke. A population-based case-control study in Perth, Western Australia. Stroke [Internet]. 1994 [cite 2023 Aug 1]; 25: 51–59. Available from: https://pubmed.ncbi.nlm.nih.gov/8266383/
[88] Strazzullo, P, D'Elia L, Kandala NB, Cappuccio, FP. Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. BMJ [Internet]. 2009 [cite 2023 Aug 1]; 339: b4567. Available from: https://pubmed.ncbi.nlm.nih.gov/19934192
[89] Sarikaya H, Ferro J. Arnold M. Stroke prevention--medical and lifestyle measures. Eur Neurol [Internet]. 2015 [cite 2023 Aug 1]; 73(3-4): 150-7. Available from: https://pubmed.ncbi.nlm.nih.gov/25573327/

[90] Kleindorfer DO, Towfighi A, Chaturvedi S, Cockroft KM, Gutierrez J, Lombardi-Hill D. 2021 Guideline for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack: A Guideline From the American Heart Association/American Stroke Association. Stroke [Internet]. 2021 [cite 2023 Aug 1]; 52(7): e364–e467. Available from: https://www.ahajournals.org/doi/10.1161/STR.0000000000000375
[91] Larsson SC, Burgess S, Michaëlsson K. Smoking and stroke: A mendelian randomization study. Ann Neurol [Internet]. 2019[cite 2023 Aug 1]; 86(3): 468–471. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6701987/
[92] World Health Organization [Internet]. Geneva: World Health Organization: c2023. Tobacco Thailand 2021 country profile: 2021 [cite 2023 Aug 1]. Available from: https://www.who.int/publications/m/item/tobacco-tha-2021-country-profile
[93] Paffenbarger RS Jr, Wing AL, Hyde RT, Jung DL. Physical activity and incidence of hypertension in college alumni. Am J Epidemiol [Internet]. 1983[cite 2023 Aug 1]; 117(3): 245-57. Available from: https://pubmed.ncbi.nlm.nih.gov/6829553/
[94] Gallanagh S, Quinn TJ, Alexander J, Walters MR. Physical activity in the prevention and treatment of stroke. ISRN Neurol [Internet]. 2011[cite 2023 Aug 1]: 953818. Available from: https://pubmed.ncbi.nlm.nih.gov/22389836/
[95] Physical Activity Guidelines Advisory Committee. Physical activity advisory committee report 2008 [Internet]. Washington, DC: US Department of Health and Human Services: 2008 [cite 2023 Aug 1]. Available from: https://academic.oup.com/nutritionreviews/article-pdf/67/2/114/24093200/nutritionreviews67-0114.pdf
[96] Eckel RH, Jakicic JM, Ard JD, de Jesus JM, Houston Miller N, Hubbard VS, et al. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation [Internet]. 2014 [cite 2023 Aug 1]; 129(suppl 2): S76–S99. Available from: https://pubmed.ncbi.nlm.nih.gov/24222015/
[97] Skajaa N, Adelborg K, Horvath-Puho E, Rothman KJ, Henderson VW, Thygesen LC, et al. Risks of stroke recurrence and mortality after first and recurrent strokes in Denmark: a nationwide registry study. Neurology [Internet]. 2022 [cite 2023 Aug 1]; 98(4). Available from: https://n.neurology.org/content/98/4/e329.long
[98] Coull AJ, Lovett JK, Rothwell PM. Population based study of early risk of stroke after transient ischaemic attack or minor stroke. implications for public education and organisation of services. BMJ [Internet]. 2004 [cite 2023 Aug 1]; 328: 326. Available from: https://pubmed.ncbi.nlm.nih.gov/14744823/
[99] Mohan KM, Wolfe CD, Rudd AG, Heuschmann PU, Kolominsky-Rabas PL, Grieve AP. Risk and cumulative risk of stroke recurrence: a systematic review and meta-analysis. Stroke [Internet]. 2011 [cite 2023 Aug 1]; 42: 1489-1494. Available from: https://pubmed.ncbi.nlm.nih.gov/21454819/
[100] Suwanwela NC. Stroke epidemiology in Thailand. J Stroke [Internet]. 2014 [cite 2023 Aug 1]; 16(1): 1-7. Available from: https://pubmed.ncbi.nlm.nih.gov/24741559/
[101] Diener H, Hankey GJ. Primary and secondary prevention of ischemic stroke and cerebral hemorrhage. Journal of American College of Cardiology [Internet]. 2020 [cite 2023 Aug 1]; 75(15): 1804-1818. Available from: https://pubmed.ncbi.nlm.nih.gov/32299593/
[102] Kitagawa K, Yamamoto Y, Arima H, Maeda T, Sunami N, Kanzawa T, et al. Effect of standard vs intensive blood pressure control on the risk of recurrent stroke: a randomized clinical trial and meta-analysis. JAMA Neurol [Internet]. 2019 [cite 2023 Aug 1]; 76(11): 1309-1318. Available from: https://pubmed.ncbi.nlm.nih.gov/31355878/
[103] Rashid P, Leonardi-Bee J, Bath P. Blood pressure reduction and secondary prevention of stroke and other vascular events: a systematic review. Stroke [Internet]. 2003 [cite 2023 Aug 1]; 34(11): 2741-2748. Available from: https://pubmed.ncbi.nlm.nih.gov/14576382
[104] Odden MC, McClure LA, Sawaya BP, White CL, Peralta CA, Field TS, et al. Achieved blood pressure and outcomes in the Secondary Prevention of Small Subcortical Strokes Trial . Hypertension [Internet]. 2016 [cite 2023 Aug 1]; 67: 63-69. Available from: https://pubmed.ncbi.nlm.nih.gov/26553236/
[105] Amarenco P, Labreuche J. Lipid management in the prevention of stroke: review and updated meta-analysis of statins for stroke prevention. Lancet Neurol [Internet]. 2009 [cite 2023 Aug 1]; 8: 453–63. Available from: https://pubmed.ncbi.nlm.nih.gov/19375663/
[106] Mach F, Baigent C, Catapano AL, Koskinas KC, Casula M, Badimon L, et al. ESC/EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk: The Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and European Atherosclerosis Society (EAS). Eur Heart J [Internet]. 2020 [cite 2023 Aug 1]; 41(1): 111-188. Available from: https://academic.oup.com/eurheartj/article/41/1/111/5556353
[107] Horodinschi RN, Stanescu AMA, Bratu OG, Pantea Stoian A, Radavoi DG, Diaconu CC. Treatment with Statins in Elderly Patients. Medicina (Kaunas) [Internet]. 2019 [cite 2023 Aug 1]; 55(11): 721. Available from: https://pubmed.ncbi.nlm.nih.gov/31671689/
[108] Collins R, Reith C, Emberson J, Armitage J, Baigent C, Blackwell L, et al. Interpretation of the evidence for the efficacy and safety of statin therapy. Lancet [Internet]. 2016 [cite 2023 Aug 1]; 388 (10059): 2532–2561. Available from: https://pubmed.ncbi.nlm.nih.gov/27616593/
[109] Ray KK, Seshasai SR, Wijesuriya S, Sivakumaran R, Nethercott S, Preiss D, et al. Effect of intensive control of glucose on cardiovascular outcomes and death in patients with diabetes mellitus: a meta-analysis of randomised controlled trials. Lancet [Internet]. 2009 [cite 2023 Aug 1]; 373: 1765–72. Available from: https://pubmed.ncbi.nlm.nih.gov/19465231/
[110] Gerstein HC, Miller ME, Genuth S, IsmailBeigi F, Buse JB, Goff DC Jr, et al. Long-term effects of intensive glucose lowering on cardiovascular outcomes. N Engl J Med [Internet]. 2011 [cite 2023 Aug 1]; 364: 818–828. Available from: https://pubmed.ncbi.nlm.nih.gov/21366473
[111] American Diabetes Association. Standards of medical care in diabetes - 2021. Diabetes Care [Internet]. 2021 [cite 2023 Aug 1]; 44(Supplement 1): S1-S232. Available from: https://diabetesjournals.org/care/issue/44/Supplement_1
[112] Kernan WN, Viscoli CM, Furie KL, Young LH, Inzucchi SE, Gorman M, et al. Pioglitazone after ischemic stroke or transient ischemic attack. New England Journal of Medicine [Internet]. 2016 [cite 2023 Aug 1]; 374(14): 1321-1331. Available from: https://pubmed.ncbi.nlm.nih.gov/26886418/
[113] American Heart Association. Prevention and treatment of stroke in patients with diabetes mellitus: A scientific statement from the American Heart Association and American Diabetes Association. Stroke. 2021; 52(4): e44-e75.
[114] American Heart Association [Internet]. Illinois: American Heart Association, Inc: c2023 [cite 2023 Jul 25]. Available from: https://www.heart.org/en/health-topics/atrial-fibrillation
[115] Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, Casadei B, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. Eur Heart J [Internet]. 2016 [cite 2023 Aug 1]; 37(38): 2893–2962. Available from: https://academic.oup.com/eurheartj/article/37/38/2893/2334964
[116] National Heart, Lung, and Blood Institute [Internet]. Maryland: National Heart, Lung, and Blood Institute: 2022. Atrial Fibrillation: 2022 [cite 2023 Jul 25]. Available from: https://www.nhlbi.nih.gov/health-topics/atrial-fibrillation
[117] Baert I, Feys H, Daly D, Troosters T, Vanlandewijck Y. Are patients 1 year post-stroke active enough to improve their physical health? .DisabilRehabil [Internet]. 2012 [cite 2023 Aug 1]; 34(7): 574-580. Available from: https://pubmed.ncbi.nlm.nih.gov/21981331/
[118] Yan LL, Li C, Chen J, Miranda JJ, Luo R, Bettger J, et al. Prevention, management, and rehabilitation of stroke in low- and middle-income countries. eNeurologicalSci [Internet]. 2016 [cite 2023 Aug 1]; 2(2): 21-30. Available from: https://pubmed.ncbi.nlm.nih.gov/29473058/

