

บทความวิจัย

The Development of a Geographic Information System for Improving the Accessibility of Emergency Care for Stroke Patients in Khlong Khlung District, Kamphaeng Phet Province, Thailand

Somsak Thojampa*

Phudit Tejavivaddhana**

Kanida Narattharaksa ***

Suthi Hantrakul****

Received: Dec 12, 2018

Revised: Jan 15, 2019

Accepted: Jun 5, 2019

บทคัดย่อ

This action research aimed to develop a geographic information system to assist stroke patients and families in seeking emergency medical services (EMS) provided by hospitals and health care facilities. The geographic information system (GIS) in this study was designed by practitioners, healthcare providers, community leaders, and village health volunteers. The developed semi-structured questionnaire was verified by an expert panel before the effectiveness of this tool was tested. Ten at-risk stroke patients simulated a pilot study by calling the EMS hotline to report a stroke emergency, and the nearby hospital dispatched ambulance to pick up the at-risk patient from their home. Outcomes were measured including practitioners' satisfaction towards using the developed GIS.

The results showed that the pilot study that was simulated met the Khlong Khlung Hospital's goal. The ten at-risk stroke patients that were delivered by EMS ambulance from their house to Khlong Khlung Hospital took less than two hours ($\bar{X} = 1.25$ hour), starting from the time the hotline received calls. It was found that the community was satisfied with the GIS (Very good). The data collection processes undertaken by the team included: analysis, planning and designing, reporting and presenting data. The system was found to be efficient in establishing the implementation of a Stroke Patient EMS. It could be used as a guideline to

*Assistant Professor, Faculty of Nursing, Naresuan University, Thailand, email:somsakth@outlook.com

**Assistant Professor, ASEAN Institute for Health Development, Mahidol University, Thailand

*** Faculty of College of Health Systems Management, Naresuan University, Thailand

****Deputy Mayor of Phitsanulok Municipality, Thailand

establish the emergency medical services in addressing stroke as well as to increase participating medical facilities that are covered by Kamphaeng Phet province.

Keywords: Geographic Information System, Stroke, Accessibility, Emergency Medical Services

Introduction

Stroke is a well-known disease caused by disruption of blood circulation in the brain resulting in neurological problems (Giraldo, 2011). It is an emergency illness that requires timely treatment to prevent disability and death. This disease is the second leading cause of death and disability in the world (Bonita, Mendis, Truelsen, Bogousslavsky, Toole, & Yatsu, 2004). In 2013, there were 25.7 million stroke survivors worldwide and over six million deaths resulting from stroke. New cases were reported over ten million in 2013 (Venketasubramanian, Yoon, Pandian, & Navarro, 2017). Stroke burden is a contributor to economic losses due to the inability of the stroke patient to resume employment. The cost of strokes in the United States was approximately 65.5 billion US dollars while the total annual cost of stroke around the European Union was about 27 billion Euros (DiCarlo, 2009). According to the report of the National Highway Traffic Safety Administration (2014), Thailand has suffered losses of several million baht per year mostly on caring for disabilities brought about by a stroke. The national health care system compensates the cost of this treatment, but the usage is still limited to tertiary hospitals (Venketasubramanian et al., 2017).

The prevalence of stroke in Asia is higher compared to the western population (Venketasubramanian et al., 2017). Causes and treatment strategies vary by stroke types. This disease is also a significant cause of disability in adults and older adults (Venketasubramanian et al., 2017). The initial symptoms of the disease include physical weakness, slurred speech, face drooping or

numbness. If left untreated, stroke can cause severe long-term effects on the body, such as difficulty in walking and speaking disorders (Hackett, Yapa, Parag, & Anderson, 2005). Stroke patients also become very emotional and could suffer from depression (Hackett et al., 2005). The best way to reduce the stroke burden is to prevent it, in spite of the emergence of treatments of some cases of stroke (Sacco, et al., 1997)

In Thailand, stroke is the third leading cause of death in both men and women (Poungvarin, 2007). The prevalence of stroke in Thailand is 1.88 percent (Suwanwela, 2014). Adult men over 45 years of age are more likely to have a stroke compared to women over the age of 65 years old (Venketasubramanian, et al., 2017). Globally, the significant risk factors of stroke include air pollution, poor diet, low physical activity, tobacco smoke and physiological (Feigin et al., 2016). Risk factors for Thai people include hypertension, diabetes, high blood cholesterol, and heart disease (Venketasubramanian et al., 2017). Ischemic stroke is the most common type of stroke in Thailand. Stroke is a disease that must be treated promptly. Emergency treatment with intravenous thrombolytic therapy has been used to treat stroke in Thailand for more than twenty years. Currently, a rapid stroke monitoring system is in place although there are still restrictions (Suwanwela, 2014). Additionally, there is limited access to data on the prevalence of stroke in Thailand.

Emergency medical services (EMS) is an integral part of the health care delivery system that saves patients

life around the world (National Highway Traffic Safety Administration, 2014). EMS helps to fasten the evaluation and treatment of stroke. However, EMS has limitations in that most stroke patients lack the capacity to activate EMS. Due to privacy concerns, the receiving hospital may experience difficulty in accessing patient outcomes, thereby making it hard to follow up on the patient's progress or history in the future (Ciliberti-Vargas et al, 2018) In Thailand, the EMS and the health facility services in the community are managed by the Sub-District Administrative Organization and health care center (National Highway Traffic Safety Administration, 2014). It is available for emergency services twenty-four hours a day and seven days a week. All the emergency patients can call the hotline 1669 to access the service (National Highway Traffic Safety Administration, 2014). The National Health Security Office (NHSO) has established guidelines for the accessibility of emergency services. The Stroke Fast Track provides services for people with neurological symptoms such as paralysis, slurred speech, and varying strength of limbs to get diagnosed and treated promptly (getting antiplatelet drug within 4 hours from the onset of symptoms) (Khlung Khlung District's report, 2018).

Khlung Khlung district is in Kamphaeng Phet province (KPT), located in the lower north of Thailand. This province was divided into 11 districts (Amphoe) including Mueang Kamphaeng Phet, Sai Ngam, Khlung Lan, Khanu Woraklaksaburi, Phran Kratai, Lan Krabue, Sai Thong Watthana, Pang Sila Thong, Bueng Samakkhi, Kosamphi Nakhon, and Khlung Khlung.

Khlung Khlung is located in the central part of KPT. This district was divided into ten sub-districts (Tambon). One sub-district using the same name comprises of 9 villages with one director each. In every community, health care providers work with Village Health Volunteers (VHV). VHV are essential for health care services because they are close and provide self-care to patients.

One volunteer takes care of ten families (Khlung Khlung District's report, 2018).

Khlung Khlung hospital is a secondary hospital with ninety beds. There are one hundred-five employees including ten physicians, seventy-one nurses, and twenty-four other staffs. The service departments are the outpatient's department, inpatients department, special clinic, and emergency department. However, this hospital has limited access to antiplatelet therapy and cerebral x-ray computers. These protocols have many effects on stroke patients. According to the risk management, the hospital guidelines for stroke fast-track service indicates that the patient should reach the hospital within two hours from the onset of the symptoms, then refer the patients to a tertiary hospital to receive anticoagulant therapy within four hours from the start of symptoms.

The Strong Stop Stroke Project has been funded by the District Health System (DHS) StartUp because of the steady increase of incidences of stroke in Khlung Khlung district. In the past three years from 2014 to 2016, the mortality rates of stroke patients in Khlung Khlung district were 44.70, 56.19 and 57.47 per 100,000 populations respectively; and the morbidity rates were 650.05, 681.97 and 767.54 per 100,000 populations respectively (Khlung Khlung District's report, 2018). While compared with the incidence in the whole country, the mortality rates were 71.76, 48.85 and 57.40 per 100,000 populations, and the morbidity rates were 685.83, 791.36 and 863.74 per 100,000 populations (Khlung Khlung District's report, 2018). The stroke report by Health Service in Region 3, included KPT, between 2014 to 2016, showed that the mortality rates were 39.00, 49.55, and 64.46 per 100,000 populations, and the morbidity rates were 720.94, 833.95 and 888.48 per 100,000 populations (Khlung Khlung District's report, 2018).

In the past three years from 2014 to 2016, the morbidity rates from stroke in KPT were 74.37, 73.09 and 61.93 per 100,000 population; and the morbidity rates

from stroke were 862.68, 919.81 and 962.53 per 100,000 population (Khlung Khlung District's report, 2018). The death rates and stroke rates of KPT were higher than those of the country (Khlung Khlung District's report, 2018). According to the health Services Region 3office, the morbidity and mortality rates for stroke are expected to increase each year(Khlung Khlung District's report, 2018) .As a result of the operation from 2014 to 2016, the Fast Track project did not meet the desired goal (80%) of caring for stroke patients by accessing the service of Khlung Khlung Hospital. (Khlung Khlung District's report, 2018).

Access to emergency or health care facilities can be evaluated by use of Geographic Information System (Saijo, Yoshioka, Kawanishi, Nakagi, Hanley & Yoshida, 2018). A Geographic Information System (GIS) is a spatial information application that can be operated with the use of a computer (Jirakajornkul, 2009). The information that is showed to the location in the Spatial Database Management is related to the position of the patient in the map. Data and maps in GIS are in the form of tables and graphs (Jirakajornkul, 2009). The program used in GIS is the ArcView program, developed by Environmental System Research Institute (ESRI) from the United States. This program was widely used to present information with the use of data retrieval and analysis in many countries. It can be used quickly and efficiently. It works on Windows operating system, which displays information on the screen, and allows the opening of multiple windows during operation (Jirakajornkul, 2009). The development of GIS for stroke was structured into three categories: 1) personal data, 2) stroke risk screening, and 3) location of high-risk patients (Khlung Khlung District's report, 2018).

The research academics team effectively and efficiently helped Khlung Khlung Hospital to overcome

the challenges on patients' accessibility to Emergency Medical Services by developing the information systems - GIS, thus reduce mortality and morbidity rate.

Research Objectives

1. To develop a geographic information system to assist persons with stroke and their families in seeking the emergency medical services provided by hospitals and health care facilities

2. To evaluate the use of geographic information technology system in managing the care for persons with stroke.

Methodology

This study on action research (Kemmis & McTaggart, 1992) by integrating the concept of Community-Based Approach which is a community problem-solving process. It is essential to bring the outstanding talent of individuals and family in the community combined with a participatory democracy to implement sustainable solutions. The procedures are as follows: 1) The situation analysis 2) Determining the operation plan and solving the problems 3) Implementation and 4) considering and evaluating. The process focuses on creative participation processes by using group discussions, brainstorming interviews, and opinions on how to use the system to collect data. Data were collected between September and December 2018. Approval for this research involving human subjects was obtained from the Naresuan University Institutional Review Board (COA No.062/2017) before starting the investigation. The research team consisted of ten people who are health care providers and an academic advisor. This research applied mobile devices as the tools for data collection because of their ease of use in presenting and processing information efficiently.

The researchers examined the **reliability** of the instruments using internal consistency. The developed semi-structured questionnaire was sent to two qualified professionals (doctor and nurse) who were working in the community, and one Information Technology (IT) expert on GIS. The experts verified the efficiency of the tool. They used the stratified questionnaire to assess the satisfaction with database development. The surveys were developed by the author and have undergone good content validity; the reliability of the questionnaires was examined using the Cronbach alpha coefficient with a score of 0.74. This research includes four phases:

Phase 1: Situation Analysis:

The situation analysis to identify the problems and needs of the community was done by literature review, in-depth interviews, observations, and brainstorming. The research team met with the stakeholders which includes twenty village health volunteers, nine village directors, and ten members of the community by using group discussions to discuss the solution to the Fast Track project that did not meet the desired goal.

Phase 2: Determining the operation plan for solving the problems:

The researchers determined the operational plan to solve the problems by utilizing the results of the situation analysis from phase one and then drafting a geographic information system development plan. The research team conducted a meeting with the ten village health volunteers, nine village directors and five healthcare providers from the community that enabled the preparation of the community stakeholders and then planned the implementation, and developed the geographic information system for supporting the health care management of stroke patients in their community.

Phase 3: The action research method used in this study consisted of seven stages.

1) Two hours meeting by using group discussions

was convened to obtain the opinions and needs of the stakeholders including village health volunteers, the village director, and the members of the community for the geographic information system that would be used to support the health care management of stroke patients in their community.

2) The stakeholders participated in the data collection process for the system that would control stroke in the city.

3) After the data collection process, three hours training was conducted to demonstrate how to use the designed GIS and how to fill both risk data and personal information instruments for at-risk stroke patients.

4) The healthcare volunteers performed data collection in the community using the devices. The Village Health Volunteers and the village directors provided their contact information together with the at-risk patient data.

5) A meeting of the stakeholders was called to analyze all the data collected and verify that the data was comprehensive and without any missing information.

6) Presenting the results of the pilot study through team discussion on whether it was practically possible and if it met the community needs or not.

7) A pilot study was simulated by asking ten at-risk stroke patients to call the EMS hotline, which connected with the GIS system at the Khlong Khlung Hospital to report a stroke emergency. The EMS center of the Khlong Khlung Hospital then called the nearby hospital dispatched the ambulance to pick up the at-risk patient from their house to the hospital. The goal was for the patient to be delivered by the EMS ambulance from their home to Khlong Khlung Hospital within two hours from the time that the patient called the hotline.

Phase 4: Evaluation and reflection of the results at the end of the research process of the pilot study.

This process was done by measuring the time of the EMS process, from the time the at-risk stroke patients called the EMS hotline until the time they accessed the

service of Khlong Khlung hospital. The five items of the stratified questionnaire were used to assess the satisfaction of the database development by the ten health care providers who worked in relation to the EMS service of Khlong Khlung hospital. In addition, the research team made a final evaluation to find conclusions about the weaknesses, problems, and obstacles that were encountered.

Research Results

The results were divided into four phases. The findings revealed as the followings:

Phase 1: The Situation Analysis found that the problem of the Fast Track project was that it did not meet the desired goal (80%) of caring for stroke patients in accessing the service of Khlong Khlung hospital. The problem was that most patients and their relatives could not assess the signs and symptoms of stroke because they were not aware that what they were experiencing was already a stroke. Patients would, therefore, delay their access to the Stroke Fast Track system thinking that the signs and symptoms that they encountered were not severe. Stroke patients who called the EMS ambulance service amounted to only fifteen percent of all reported cases. Most stroke patients would go to the hospital by themselves without calling the EMS.

Phase 2: Determining the operation plan for solving the problems. The needs of the community for the geographic information system in managing stroke included the following:

1) Personal data collection including the at-risk patient's name, age, smoking, waist circumference, hypertension, diabetes, high blood cholesterol. It also included the family and medical history; parents, children who were diagnosed with myocardial infarction, coronary artery bypass surgery, use of a balloon to expand the blood vessels in the heart, paralysis, death

from coronary heart disease before 55 years old (men) and before 65 years old (women).

2) Information about the village directors and the health volunteers that live nearby the at-risk stroke patients that can be contacted when there is an emergency.

3) Information about emergency medical services and neighboring health facilities such as community health centers by the sub-district administrative organization.

Phase 3: Developing the geographic information system for stroke management in the community. This was a result of the health care team decisions to manage stroke until the final geographic information system model was developed as shown in Figure 1.



Figure 1 The locations of families with stroke risk including low-, moderate-, and high-risk groups. (Green = low-risk group, Yellow = medium-risk group, Red = high-risk group) and The location of the emergency medical services (EMS)



Figure 2 The pathway from the at-risk stroke patient's house to the emergency medical service facilities

Phase 4: The result of the evaluation of the GIS showed that the pilot study that was simulated met the goal. Ten at-risk stroke patients were delivered by the EMS ambulance from their house to Khlong Khlung Hospital within two hours ($\bar{X} = 1.25$ hour) from the time that the patient called the hotline. That means that it can be used as a guideline for the development of emergency medical services to address stroke and to

increase medical facilities that are covered by (KPT) province. The stakeholders were satisfied by the results. Therefore, the GIS was able to obtain its purpose and can be used in the health care service for stroke management. Based on the pilot study of the system, the evaluation by health care providers was also satisfactory (see Table 1.). By letting the community be involved in planning, designing and even with the comprehensive report and

presentation of the results, the GIS and data collection method was developed successfully.

The results of the GIS can be used to support the health care providers in making the right decisions and plan for patients, and help the emergency patients with early symptoms of stroke to get treated within the golden

period. They can also be used as a guideline for the development of EMS and to increase the medical facilities to cover the area of (KPT) province. Besides, the data can be used to make decisions about the management of the health care system for stroke patients in other communities.

Table 1 GIS evaluation by stakeholders (n = 10)

Content	\bar{X}	(S.D.)	Satisfactory Level
1. Respond to the needs of users	4.63	0.58	Very good
2. Accuracy of information systems	4.50	0.63	Very good
3. Convenient and easy to use	4.68	0.51	Very good
4. Can actually be used	4.88	0.45	Very good
5. Overview of satisfaction	4.65	0.55	Very good
Summary	4.67	0.54	Very good

Discussion

This study is action research, where the application of research results is used to solve the stroke problem by community participation, considering empirical data and clear operating procedures that meet the intended purpose.

Phase 1: The Situation Analysis explored the problems and needs of the community.

From the situation analysis, it was found that the problem of the Fast Track project was that it did not meet the desired goal (80%) of caring for stroke patients who accessed the fast track service of Khlong Khlung hospital. The community needed to develop a geographic information database to be used in the analysis and planning of emergency medical services, specifically the emergency access of stroke patients in Khlong Khlung hospital. There was a need for a more effective plan for stroke management. Williams, Costa, Odunlami & Mohammed (2008) states that a complete lack of information makes policy implementation of health care unsuitable for the context in the area. The World Health

Organization (2014) has suggested that health and social development should be aligned.

Phase 2: Determining the operation plan for solving the problems.

The need of the community found was developing a geographic information system in managing stroke. The community commented on the content coverage and proposed health issues that needed to be addressed. If the data collection is done by community participation, then it will help in all stages of development in health care (WHO, 2014). The community suggested that the database format should be easy to use; the validated data should be readily available and be suitable for potential needs of the city. In the development of health information systems process, issues need to be considered at all stages to maximize the cost-effectiveness of the system to meet the needs of the user (Boonchieng, Boonchieng, Senaratana, & Singkaew, 2014).

Phase 3: Developing the geographic information system by collecting Personal Information.

Personal information is useful for identifying individuals and can be used to contact and coordinate emergency medical services on time. Screening to identify risk factors for at-risk patients in the area was used in the data collection. The health care providers should pay particular attention to high-risk groups in their community. Their coordinates are essential information in the planning of routes of emergency service ambulances. It helps in making traffic decisions about travel time for medical emergency orders. Explicit coordinates will improve the management of emergency medical units to work more efficiently in responding to these requests.

Phase 4: Evaluation and reflection on the Geographic Information System (GIS).

The results showed that applying the GIS system with EMS service can help the at-risk stroke patients to get into the Stroke Fast Track services of Khlong Khlung Hospital within two hours. According to the study of Klawwikan and Jirakajohnkool (2014) stated that applying GIS with Emergency service can help emergency patients access the Emergency services within ten minutes. The assessment of satisfaction with database development revealed that stakeholders were satisfied with the GIS. When the concept of education is well framed, and the need for analysis and level of analysis is clear, therefore, the community is satisfied - getting involved in database development is vital for the community (Sirilak, Okanurak, Wattanagoon, Chatchaiyalerk, Tornee, & Siri, 2013). The most advantageous use of the database is the continuity of community involvement. Developing a database for supporting health care management will have better results since they will be empowered to take care of their health problems.

Conclusion

The developed geographic information system (GIS) assists persons with stroke and their families in seeking the emergency medical services provided by hospitals

and health care facilities by integrating the concept of Community-Based Approach which is a community problem-solving process. It is essential to bring the outstanding talent of individuals and family in the community combined with a participatory democracy to implement sustainable solutions. By letting the community be involved in planning, designing and even with the comprehensive report and presentation of the results, the GIS and data collection method was developed successfully. Another objective was evaluating the use of geographic information technology system in managing the care for persons with stroke. The result of the evaluation of the GIS showed that the pilot study that was simulated met the goal and also the stakeholders were satisfied by the results. The GIS can be used to support the health care providers in making the right decisions and plan for patients, and help the emergency patients with early symptoms of stroke to get treated within the golden period. Finally, developing of the GIS for improving the accessibility to emergency care for Stroke Patients in Khlong Khlung District, Kamphaeng Phet Province, Thailand was successful, because the GIS system with EMS service can help the at-risk stroke patients to get into the Stroke Fast Track services of Khlong Khlung Hospital within the golden period.

Recommendations

The results showed that the GIS could be used to plan the implementation of a Stroke Patient Emergency Care System. It can be used as a guideline for the development of emergency medical services to address stroke and to increase medical facilities that are covered by (KPT) province. The accessibility of use and presentation, as well as the process of information, were efficient. Meanwhile, future research may apply data collection with mobile devices. These data need to be confirmed in intervention studies with an accompanying evaluation of the clinical consequences as well as the level of patient satisfaction.

References

- Bonita, R., Mendis, S., Truelsen, T., Bogousslavsky, J., Toole, J., & Yatsu, F. (2004). The global stroke initiative. *The Lancet Neurology*, 3(7), 391-393.
- Boonchieng, E., Boonchieng, W., Senaratana, W., & Singkaew, J. (2014). Development of mHealth for public health information collection, with GIS, using private cloud: A case study of Saraphi district, Chiang Mai, Thailand. *International Computer Science and Engineering Conference (ICSEC)*, 350-353. [In Thai].
- Ciliberti-Vargas, M. A., Gardener, H., Wang, K., Dong, C., Yi, L., Romano, J. G., ...Rundek, T. (2017). Stroke Hospital characteristics in the Florida-Puerto Rico collaboration to reduce stroke disparities study. *Southern medical journal*, 110(7), 466-475.
- Di Carlo, A. (2009). Human and economic burden of stroke. *Age and Ageing*, 38(1), 4-5.
- Feigin, V. L., Roth, G. A., Naghavi, M., Parmar, P., Krishnamurthi, R., Chugh, S., ...Estep, K. (2016). Global burden of stroke and risk factors in 188 countries, during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet Neurology*, 15(9), 913-924.
- Giraldo, E. A. (2011). *Overview of stroke (cerebrovascular accident)*. *The Merck manual for health care professionals*. Retrieved 1 December 2018 from <http://www.merckmanuals.com/professional/sec17/ch221/ch221a.html>.
- Hackett, M. L., Yapa, C., Parag, V., & Anderson, C. S. (2005). Frequency of depression after stroke: a systematic review of observational studies. *Stroke*, 36(6), 1330-1340.
- Jirakajornkul, S. (2009). Learn Geometry with Arc GIS Desktop 9.3.1: *Textbook of Geography Information 1*. Nonthaburi: S.R. Printing Mass Products Limited. [In Thai].
- Kemmis, S., & McTaggart, R. (1992). *The Action Research Planner* (3rd ed.). Geelong: Deakin University Press.
- Khlong Khlung Hospital. (2018). Statistic report of Stroke: 2014-2016. *Khong Khlung Hospital, Kampaengphet Province*. Kampaengphet: Khlong Khlung Hospital. [In Thai].
- Klawwikan, P., & Jirakajohnkool, S. (2014). Application of Geographic Information Systems for Service Area Analysis of Emergency Medical Service Centers in Loei Province, *Thai Journal of Science and Technology*, 3(3), 137-147. [In Thai].
- National Highway Traffic Safety Administration. (2014). *Ministry of information and communication technology communication*. Bangkok: National Highway Traffic Safety Administration. [In Thai].
- Phinyo, K., Limtragool, P., Tiamkao, S., Worawong, C., Chuasuan, W., Aphiphatkan, W., ... Sripromsa, W. (2015). Care improvement for patients with stroke through community participation. *Songklanagarind Journal of Nursing*, 35(2), 93-112. [In Thai].
- Poungvarin, N. (2007). Burden of stroke in Thailand. *International Journal of Stroke*, 2(2), 127-128.
- Sacco, R. L., Benjamin, E. J., Broderick, J. P., Dyken, M., Easton, J. D., Feinberg, W. M., ... Wolf, P. A. (1997). *Risk factors*. *Stroke*, 28(7), 1507-1517.
- Saijo, Y., Yoshioka, E., Kawanishi, Y., Nakagi, Y., Hanley, S. J. & Yoshida, T. (2018). Relationships between road distance to primary care facilities and ischemic heart disease and stroke mortality in Hokkaido, Japan: A Bayesian hierarchical approach to ecological count data. *Journal of general and family medicine*, 19(1), 4-8.
- Sirilak, S., Okanurak, K., Wattanagoon, Y., Chatchaiyalerk, S., Tornee, S., Siri, S. (2013). Community participation of cross border migrants for primary health care in Thailand. *Health policy and planning*, 28(6), 658-664.

- Suwanwela, N. C. (2014). Stroke Epidemiology in Thailand, *Journal of Stroke*, 16(1), 1-7.
- Venketasubramanian, N., Yoon, B. W., Pandian, J. & Navarro, J. C. (2017). Stroke Epidemiology in south, east, and south-east Asia: a review. *Journal of stroke*, 19(3), 286-289.
- Williams, D. R., Costa, M. V., Odunlami, A. O., & Mohammed, S. A. (2008). Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities. *Journal of public health management and practice: JPHMP*, 14(8), 158-163.
- World Health Organization. (2014). *Community involvement in Health*. Retrieved 30 September 2015 from <http://www.afro.who.int/en/clustersa-programmes/hss/health-policya-service->.