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ORIGINAL ARTICLE

Impact of the quality of care and other factors on stroke among patients with hypertension in Thailand

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Abstract

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Hypertension is a global pandemic and its prevalence is dramatically increasing in developing countries, including Thailand. Quality care and appropriate care will result in reduction in the incidence of hypertension complications. This study aimed to investigate the effects of quality of hypertension care and other factors on stroke among hypertensive patients. The current study is a nationwide, multicenter, cohort study of hypertension outpatients who visited 595 hospitals across Thailand. A generalized linear mixed model with a logit link was employed for all modeling.

Of the 6,621 hypertension patients who were assessed at least two years between the periods 2011 - 2013 included in the study, 64.2 % were females, and the mean age was 62.4 years with the standard deviation of 10.5. After adjusting for covariates, the process of care, especially achievement of the fasting plasma glucose examination, leads to a 67 % reduction in the odds of any stroke (Adj. OR=0.33, 95% CI=0.12 - 0.88). In terms of other covariates, smoking history and estimated glomerular filtration rate were also strongly associated with any stroke.

The finding has important implications for policy makers. Hypertension patients should increase fasting plasma glucose examination. The examination should be held every two months for hypertension patients who are smokers.

Keywords: structure of care, process of care, clinical target of care, cardiovascular disease, quality of care, hypertension

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ผลกระทบของคุณภาพการดูแลผู้ป่วยและปัจจัยที่เกี่ยวข้องต่อโรคหลอดเลือดสมองของผู้ป่วยความดันโลหิตสูงในประเทศไทย

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บทคัดย่อ

วรรณศรี แววงาม สุพรรณี พรหมเทศ สมศักดิ์ พิทักษานุรัตน์ วิลัยพร ถิ่นค้ารพ และ คาเมรอล เฮิร์ต ผลกระทบของคุณภาพการดูแลและปัจจัยที่เกี่ยวข้องต่อโรคหลอดเลือดสมองของผู้ป่วยความดันโลหิตสูงในประเทศไทย ลผู้ป่ ยขอ
ว. สาธารณสุขและการพัฒนา 2562;17(2):37-50

โรคความดันโลหิตสูงเป็นโรคระบาดทั่วโลก และความชุกของโรคความดันโลหิตสูงเพิ่มขึ้นอย่างรวดเร็วในประเทศกำลังพัฒนาโดยเฉพาะประเทศไทย การดูแลผู้ป่วยที่มีคุณภาพและเหมาะสมจะส่งผลให้ลดอุบัติการณ์ของภาวะแทรกซ้อนของโรคความดันโลหิตสูง งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลกระทบของคุณภาพการดูแลผู้ป่วยและปัจจัยอื่นต่อโรคหลอดเลือดสมองของผู้ป่วยความดันโลหิตสูง การวิจัยนี้เป็นการวิจัยติดตามผู้ป่วยความดันโลหิตสูงที่เป็นผู้ป่วยนอกในโรงพยาบาลทั้ง 595 แห่ง ทั่วประเทศไทย สถิติที่ใช้คือ Generalized linear mixed model

ผลการศึกษา พบว่ากลุ่มตัวอย่างเป็นผู้ป่วยความดันโลหิตสูง จำนวน 6,217 คน ที่เข้ารับบริการอย่างน้อย 2 ปี ระหว่างปี พ.ศ. 2554 ถึง 2556 เพศหญิง ร้อยละ 64.2 อายุเฉลี่ย 62.4 ปี (ส่วนเบี่ยงเบนมาตรฐาน = 10.5 ปี) หลังจากควบคุมค่าตัวแปรร่วมแล้ว การตรวจระดับกลูโคสในพลาสมานำไปสู่การลดการเกิดโรคหลอดเลือดสมอง ร้อยละ 67 (Adj. OR = 0.33, 95% CI= 0.12 - 0.88) นอกจากนั้นยังพบความสัมพันธ์ระหว่างตัวแปรที่เป็นปัจจัยเสี่ยงอื่น อาทิ การสูบบุหรี่ และอัตราการกรองของไตต่ำ

ผลการศึกษาในครั้งนี้มีความสำคัญต่อการกำหนดนโยบายในการป้องกันหรือลดความเสี่ยงของการเกิดโรคหลอดเลือดสมองในผู้ป่วยความดันโลหิตสูงที่มีการสูบบุหรี่ร่วมด้วย โดยผู้ป่วยควรได้รับการตรวจระดับกลูโคสในพลาสมาทุก ๆ 2 เดือน

คำ**ส**ำ**คัญ:** โครงสร้างของการดูแล กระบวนการดูแล
เป้าหมายทางคลินิกของการดูแล โรคหัวใจและหลอดเลือด คุณภาพการดูแลผู้ป่วย
โรคความดันโลหิตสูง

Introduction

Hypertension (HTN), or high blood pressure, is a global epidemic affecting more than one-quarter of the world's adult population.[1] In the year 2000, approximately a quarter of the world's adult population was living with HTN (972 million or 26.4 %), of which 639 million (65.7 %) living in economically developing countries. This number is expected to rise to 1.6 billion representing 29.2 % of the world adult population by 2025.[2] The consequences of HTN are a major public health problem. Prolonged high blood pressure can cause damage to target organs such as the heart, brain, kidneys, and eyes. Also, HTN is a major risk factor for death due to ischemic heart disease (45% are HTN) and stroke (51% are HTN).[3]

The goal of HTN treatment is to lower high blood pressure and subsequently reduce the development of HTN complications. The treatment of HTN requires an ongoing provider-patient's relationship that needs planned appropriate care to monitor the achievement of treatment goals. Clinical targets care includes controlling blood pressure, fasting plasma glucose and lipid, and achieving clinical targets leads to positive prognosis and prolongs the onset of HTN complications. Indeed, ongoing elevated blood pressure (systolic blood pressure ≥ 140 mm Hg), for instance, has been shown to increase the risk of ischemic heart disease by 40.1 %, hemorrhagic stroke by 42.5 %, ischemic stroke by 38.1 %, and chronic kidney disease by 44.8 %.[4]

There are few studies on the relationship of quality of hypertension care, especially clinical target care, and the development of HTN complications, and even fewer that consider the impact of clinical target achievement in mitigating risk of stroke in HTN patients. Furthermore, the results of the few studies that have been conducted provided conflicting results. The aim of the current study was to investigate the effect of quality of care and other factors on the incidence of stroke among patients with hypertension in Thailand.

Methods

Study design

This study utilized data from the study: "An Assessment of Quality of Care among Patients Diagnosed with Type 2 Diabetes (T2DM) and Hypertension Visiting Ministry of Public Health and Bangkok Metropolitan Administration Hospitals in Thailand (Thailand DM/HT)". The DM/HT study involved three yearly cross-sectional nationally representative samples of patients with HTN and T2DMfrom 595 hospitals across Thailand covering the period from 2011 to 2013. Stratified cluster sampling (provinces) using proportion to size stratification to select outpatients from 26 regional, 70 general, and 499 community hospitals (hospital size) was conducted.

For the sample used in the present study, only patients with HTN receiving medical care in participating hospitals for at least 12 months and assessed at least two years (i.e., ≥ two visits) between the periods 2011 to 2013 were included in the study. Patients with incomplete information in the outcome and/or study effect were excluded. After evaluating eligibility, a sample of 6,621 HTN patients was considered.

Study variables

The outcome variable was stroke diagnosis (any stroke) (+/-) in the previous 12 months, which included any of the following: cerebrovascular accident,

cerebral infarction, ischemic stroke, hemorrhagic stroke, cerebral hemorrhage, or non-specified stroke diagnosis (+/-). The authors did not include transient ischemic attack (TIA or mini stroke) because the symptoms occur rapidly and last only a relatively short time and may not have been observed between outpatient visits.

The main effect of interest in this study was the Quality of HTN Care (QoC), which can be subsequently split into three main types: Structure of Care (SoC), Process of Care (PoC) and achievement of Clinical Targets (CT). SoC included: type of clinic (General Medical Clinics-GMCs, Specialist Hypertension Clinics-SHCs); hospital setting (regional, general, and community); and health care coverage (universal coverage, government officer, social security scheme, and other). While health care coverage may be considered a demographic characteristic (it is associated with income/education employment category in Thailand) it is also a strong determinant of the type of clinic and/or hospital patients attended, so we include it here under 'structure of care'.

Process of care was gauged using the FUL-process as defined by the Taiwan Society of Cardiology (TSOC) guidelines[5] and the British Hypertension Society (BHS) guidelines[6] which include: Fasting plasma glucose (FPG) examination, Urine analysis (UA) examination, and Low density lipoprotein cholesterol (LDL-C) examination.

Similarly, clinical targets were evaluated using the BCG-goal, which included the Blood pressure (BP) treatment target as defined by the Eighth Joint National Committee (JNC8) guidelines[7], LDL-C treatment target as defined by the National Cholesterol Education Program (NCEP) guidelines[8], and FPG treatment target as defined by the American Diabetes Association (ADA) guidelines[9]. Specifically, the BP goal is defined as BP level lower than 150/90 mm Hg in the general population aged 60 years or older. For patients aged younger than 60 years, or concomitant Type 2 Diabetes (T2DM) or Chronic Kidney Disease (CKD), the BP target was defined as lower than 140/90 mm Hg[7]. The LDL-C goal is defined as a LDL-C level lower than 100 mg/dl[8]. The FPG goal is defined as FPG level lower than 126 mg/dl[9], as previously diagnosed by a physician.

Other covariates included as potential predictors and/or confounders in this study were age, sex, BMI classes (< 18.5, 18.5-22.9, 23.0-27.5, > 27.5 kg/m^2)[10], smoking history (never, previous, and current), duration of HTN, previous T2DM diagnosis, and estimated glomerular filtration rate (eGFR).

Statistical analysis

Patient characteristics were described using frequencies and percentages for categorical data and means and standard deviations for continuous variables. The outcome (any stroke) was represented as a binary outcome and measured longitudinally over the three years of the study. Consequently, a generalized linear mixed model (GLMM) with a logit link (binary logistic mixed effect regression) was employed for all modeling.

Bivariate and multivariable modeling was performed to obtain unadjusted and adjusted odd ratios, respectively. The multivariate model was selected using purposeful selection of covariates (PSC).[11] The authors chose this model to build algorithm because, unlike other commonly used approaches, PSC identifies and includes important confound-

ers in the model. The authors also included both a complete case and available case analysis at the bivariate level to separate and estimate missing value and confounding bias. All statistical analysis was conducted using the R statistical language (v.3.2.4)[12], GLMMs were run using the R library `lme4`[13] and a significance level of 0.05 was used for all analysis.

Ethics approval

This study was approved by the Ethics Committee for Human Research Khon Kaen University, Thailand (HE 582364). Written informed consent was obtained from all patients with HTN prior to commencing the study.

Results

During the study period (2011-2013), 140, 021 observations of patients with hypertension (HTN) were collected, of whom 126,531 (90.4 %) had a single observation and 6,621 patients (represented by 13,496 observations) had at least two observations (representing the sample used in the present study). The study flow is shown in Figure 1.

Patient characteristics

Table 1 provides the patient characteristics of the study sample (those with multiple observations), compared to patients with only a single observation. Across most variables, the study sample (patients with at least two observations) was similar to all other hypertensive patients included in the nationally representative DM/HT study. However, there were some patients' characteristics that differed marginally. For example, the repeated measures study included a higher proportion of patients attending specialist HTN clinics (SHCs) (82.3 %) compared to the sample of singleton observations from the general DM/HT dataset (78.2 %). For comorbidities variables, there was a higher proportion of existing of T2DM diagnosis (36.8 % vs. 32.3 %) in singleton observations compared to the sample (Table 1).

The percentage of any stroke of the study sample (0.3 %) was similar to all other hypertensive patients included in the DM/HT study (single observation) (omitted).

Of the 6,621 HTN patients included in the study, 4,252 (64.2 %) were females whose mean age was 62.4 years with the standard deviation of 10.5. The most frequent BMI class was 23 to 27.5 kg/m^2 (40.5 %), and most patients were never smokers (86.6 %). The mean HTN duration was 5.8 years with the standard deviation of 3.8, and the proportion of patients with an existing T2DM diagnosis was 32.5 %. The mean eGFR level was 67.5 ml/min/1.73 m^2 with the standard deviation of 23.4 (Table 1). In terms of Structure of Care (SoC), the proportion of patients attending SHCs was 82.3 %, with over half of the patients receiving care in the community hospital setting (66.6 %), and most patients having universal coverage (73.9 %). For Process of Care (PoC), 79.1%, 30.8 % and 80% of patients achieved the FPG, UA and LDL-C processes, respectively. In terms of Clinical Target, 59.2 %, 29.2 % and 58.5 % achieved the BP, LDL-C and FPG goals, respectively.

Risk factors and correlates of any stroke

The unadjusted (both available cases and complete cases) and adjusted estimates (complete cases only) of the risk factors for any stroke are shown in

Table 1 Characteristics of patients with single observation and two or more observations

Characteristics	Single obs.[a] (126,531 patients[c])		Two or more obs.[b] (6,621 patients[c])	
Structure of Care				
Clinic types				
GMCs[d]	20,444	(21.8)	870	(17.7)
SHCs[d]	73,415	(78.2)	4,038	(82.3)
Hospital types				
Regional	15,478	(12.9)	892	(14.2)
General	26,635	(22.2)	1,208	(19.2)
Community	77,911	(64.9)	4,185	(66.6)
Health care coverage				
Universal coverage	101,967	(75.2)	4,588	(73.9)
Government officer	26,720	(19.7)	1,326	(21.4)
Social security scheme	5,214	(3.8)	221	(3.6)
Other	1,734	(1.3)	73	(1.2)
Process of Care				
FPG process[d]	102,052	(80.7)	5,235	(79.1)
UA process[d]	39,446	(31.3)	2,034	(30.8)
LDL-C process[d]	103,109	(81.6)	5,287	(80.0)
Clinical Target				
BP goal[d]	77,791	(61.5)	3,922	(59.2)
LDL-C goal[d]	38,177	(30.2)	1,934	(29.2)
FPG goal[d]	72,479	(57.3)	3,876	(58.5)
Covariates				
Age, years	126,514	(62.6±11.1)	6,621	(62.4±10.5)
Female	82,251	(65.0)	4,252	(64.2)
BMI, kg/m^2[d]				
< 18.5	6,294	(5.4)	312	(5.1)
18.5 to < 23	31,461	(26.9)	1,646	(27.0)
23 to 27.5	47,428	(40.5)	2,465	(40.5)
> 27.5	31,820	(27.2)	1,667	(27.4)
Smoking history				
Never	100,493	(86.8)	4,352	(86.6)
Previous	9,647	(8.3)	444	(8.8)
Current	5,594	(4.8)	228	(4.5)
HTN duration, years	120,853	(5.8±3.9)	6,298	(5.8±3.8)
Existing of T2DM diagnosis[d]	46,587	(36.8)	2,152	(32.5)
eGFR, ml/min/1.73 m^2[d]	108,373	(67.0±23.9)	5617	(67.5±23.4)

[a] Patients that have a single observation
[b] Patients that have at least two observations
[c] Values are presented as number (%) or number (mean ± standard deviation) for continuous variables.
[d] BMI: Body Mass Index; BP goal: BP treatment target; BP: blood pressure; eGFR: estimated glomerular filtration rate; FPG goal: FPG treatment target; FPG process: FPG examination; FPG: fasting plasma glucose; GMCs: General Medical Clinics; HTN: Hypertension; LDL-C goal: LDL-C treatment target; LDL-C process: LDL-C examination; LDL-C: low density lipoprotein cholesterol; obs.: observations; SHCs: Specialist HTN Clinics; T2DM: Type 2 Diabetes Mellitus; UA process: UA examination; UA: urine analysis

Table 2 Unadjusted and adjusted odds ratios for structure of care and any stroke

	Available cases (13,496 obs.)†		Complete cases (6,637 obs.)†			
Effects	**Unadjusted OR†**	***p-value***	**Unadjusted OR†**	***p-value***	**Adjusted OR (95%CI)†**	***p-value***
Structure of Care						
SHCs, GMCs (ref.)†	0.63	0.236	0.52	0.244	0.73 (0.20-2.62)	0.623
Hospital types, Regional (ref.)†		0.583		0.510		0.728
General	1.30	0.614	2.34	0.431	1.94 (0.23-16.64)	0.544
Community	0.87	0.755	1.36	0.764	1.33 (0.16-11.31)	0.795
Health care coverage, UC (ref.)†		0.614		0.201		0.243
Government officer	1.00	0.993	0.65	0.500	0.58 (0.16-2.08)	0.404
Social security scheme	2.19	0.197	3.77	0.080	3.83 (0.73-20.05)	0.111
Other	2.19	0.443	5.18	0.115	3.59 (0.45-28.99)	0.223
Achieved BCG †	1.18	0.763	0.50	0.358	-	-
Covariates (omitted for no significant association factors)						
Smoking History, Never (ref.)†		0.002		0.001		0.003
Previous	4.40	0.001	5.82	<0.001	5.16 (1.96-13.58)	<0.001
Current	4.87	0.005	5.20	0.012	4.82 (1.32-17.51)	0.017

† Achieved BCG: Proportion of achieved of blood pressure, low density lipoprotein cholesterol, and fasting plasma glucose; CI: confidence interval; OR: odds ratio; ref.: reference

Table 3 Unadjusted and adjusted odds ratios for process of care and any stroke

	Available cases (13,496 obs.)		Complete cases (8,951 obs.)			
Effects	**Unadjusted OR**	***p-value***	**Unadjusted OR**	***p-value***	**Adjusted OR (95%CI)**	***p-value***
Process of Care						
FPG process, yes	0.71	0.344	0.37	0.038	0.33 (0.12-0.88)	0.027
UA process, yes	1.87	0.049	1.27	0.573	1.53 (0.65-3.60)	0.334
LDL-C process, yes	1.00	0.992	0.89	0.879	1.34 (0.29-6.14)	0.708
Achieved BCG	1.18	0.763	0.49	0.313	-	-
Covariates (omitted for no significant association factors)						
Smoking History, Never (ref.)		0.002		0.001		0.016
Previous	4.40	0.001	5.29	<0.001	4.55 (2.06-13.60)	0.007
Current	4.87	0.005	4.64	0.017	4.02 (1.37-16.11)	0.049

Table 4 Unadjusted and adjusted odds ratios for clinical target and any stroke

	Available cases (13,496 obs.)		Complete cases (7,513 obs.)			
Effects	**Unadjusted OR**	***p-value***	**Unadjusted OR**	***p-value***	**Adjusted OR (95%CI) †**	***p-value***
Clinical Target						
BP goal, yes	0.62	0.156	0.79	0.667	0.79 (0.26-2.36)	0.670
LDL-C goal, yes	1.32	0.440	0.83	0.756	0.76 (0.25-2.26)	0.620
FPG goal, yes	1.28	0.563	0.95	0.924	0.46 (0.09-2.40)	0.350
Covariates (omitted for no significant association factors)						
Smoking History, Never (ref.)		0.002		0.005		0.007
Previous	4.40	0.001	5.06	0.008	4.75 (1.38-16.34)	0.013
Current	4.87	0.005	7.83	0.002	7.91 (1.99-31.50)	0.003
eGFR, ml/min/1.73 m^2	0.98	0.006	0.97	0.003	0.96 (0.93-0.98)	<0.001

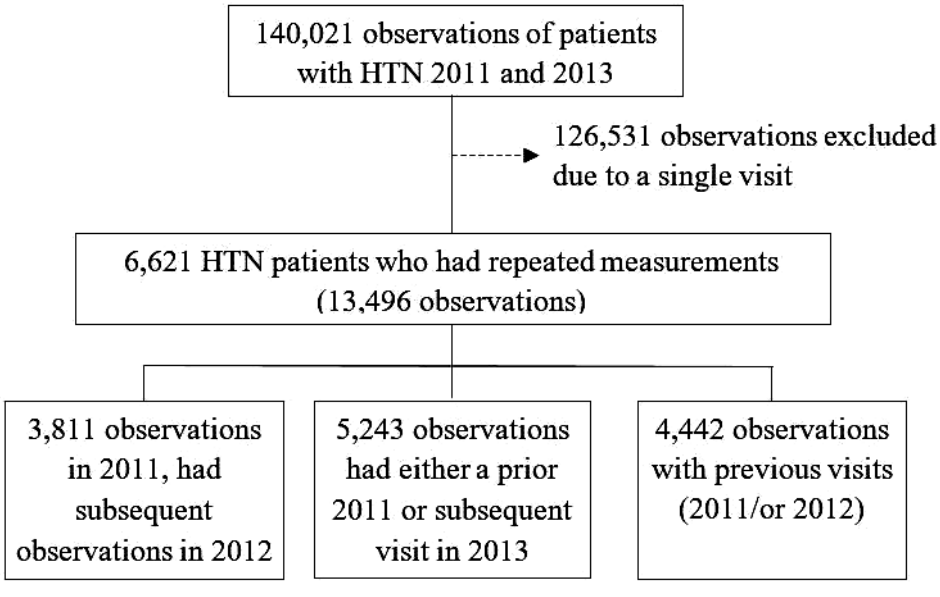

Figure 1 Flow diagram of the study

Tables 2 - 4. All multivariate analysis in those tables was performed by adjusting for age, gender, BMI, smoking history, regional, duration of HTN, existing of T2DM and eGFR.

Table 2 provides the unadjusted and adjusted odd ratios for SoC and any stroke. After adjusting for other covariates, the results indicate that no SoC predictor could be shown to be associated with any stroke. The final multivariate model demonstrates that smoking history was significantly associated with any stroke (p=0.003), namely, previous smokers having 5.16 times the odds (95 % CI = 1.96 - 13.58) and current smokers were 4.82 times the odds (95 % CI = 1.32 - 17.51) of developing any stroke relative to non-smokers (Table 2).

Table 3 provides the unadjusted and adjusted odd ratios for PoC and any stroke. The result indicated that achievement of the FPG examination lead to a 67 % reduction in the odds of developing any stroke (Adj OR=0.33; 95 % CI = 0.12 - 0.88). As one would expect, the smoking effect was significant (Table 3) and the adjusted ORs were similar to the SoC multivariate model (Table 2).

Table 4 gives the unadjusted and adjusted odd ratios for Clinical Target and any stroke. The authors found that no CT could be shown to be associated with any stroke. The final multivariate model also demonstrates that smoking history is significantly associated with any stroke (p=0.007) and the ORs remain largely unchanged from the Structure and Process of Care models. Unlike the Structure and Process of Care models, however, the Clinical Target model identified eGFR as a significant predictor of any stroke (Adj OR=0.96; 95 % CI = 0.93 - 0.98).

Discussion

HTN is a major risk factor for stroke, and the incidence of stroke is particularly high among hypertensive patients. QoC represents a way of mediating the risk of stroke and other complications among HTN patients. Understanding the effect of quality of HTN care along with other risk factors is important in gaining insight into how we can best delay the onset, or minimize the impact of HTN complications. The review of studies considering patient quality of care and stroke found no previous study has considered all components of QoC (structure, process, and clinical targets of care) in assessing risk among HTN patients. Furthermore, studies that have considered QoC typically focus on only one component[14] or focus on patients already admitted with stroke.[14-16] To the best of our knowledge, this is the first large nationwide study to assess the effect of quality of care on the incidence of stroke among HTN patients in Southeast Asia.

The results suggest that only a single indicator of the process of care is associated with the incidence of any type of stroke. The results demonstrate that FPG examination led to a substantial reduction in the incidence of stroke. HTN patients with FPG examination had a 67 % reduction in the odds of any stroke. This result may be explained by the fact that HTN patients receiving FPG examination benefit from individual health education, which in turn, may stimulate HTN patients to take better care of their health. These results are consistent with those from a previous study conducted in Denmark which revealed an association between the process of care, early mobilization, with the improvement of medical complications in patient admitted with stroke.[14]

Another study conducted in the USA demonstrated an association between the process of care and functional outcomes in poststroke patients.[16]

Interestingly, no Clinical Target could be detected to be statistically associated with the occurrence of stroke in the present study. However, despite a lack of statistical significance, the FPG goal achievement led to a substantial reduction in the odds of stroke (64%), and BP and LDL-C target achievement reduced the odds by over 20% in the study. Lack of statistical significance of Clinical Target may be explained by the fact that, despite being a relatively large cohort, the sample had a very low incidence of stroke leading to an under powered analysis. This outcome is consistent with that of Reeves *et al*[17] who demonstrated an association between treatment target care (length of stay, discharge home) and ischemic stroke outcome. Another study also found an association between treatment target and its complications.[18]

The results of the present study could not demonstrate any significant association between Structure of Care and any stroke. However, although no statistical association could be demonstrated in the population, the odds of any stroke did decrease considerably (27 %) for patients attending specialized HTN relative to those attending general medical clinics. Furthermore, the odds of any stroke for those treated at general hospitals were two times higher than those attending regional hospital clinics. The odds of any stroke decreased by 42 % for those that had government officer coverage relative to those that had universal coverage. Conversely, patients covered under the social security scheme were close to four times higher of odds of any stroke than patients with universal coverage. These results are in line with a previous study[19] that found T2DM patients attending regional and general hospital-specialized clinic receive better QoC than those attending general medical clinics. However, controversy remained, as other studies have found that SoC (systemic organization, staffing expertise, and technological sophistication) could not be shown to be associated with functional outcome in post-stroke patients.[16] Another study found no association between health care coverage and diabetes complications.[18] The same study found that the odds of complications decrease by 38 % for those attending community hospital relative regional hospitals settings. This inconsistency in results across studies may be related to different confounders as represented by case mixes in the various patient populations that have been considered or differences between resource-constrained and -sufficient health care settings.

In terms of other risk factors, the authors found that smoking history was statistically associated with any stroke among HTN patients. This is consistent with previous studies, which demonstrated that smoking history is an independent risk factor of any stroke among HTN patients.[15, 20-24] A possible explanation for this may be that cigarette smoking can narrow and thicken blood vessel[25], resulting in raised blood pressure.

The authors also found that eGFR was statistically associated with stroke among HTN patients. This result is in line with previous studies Bos *et al*[26], Zhang et al[27] and Lee et al[28] also found that decreased eGFR was related to incident stroke.

Strengths and weaknesses

There were some limitations to this study. Firstly, the follow up time was limited to a maximum of three years. This is an artifact of the study design. In this study we combined data from three consecutive yearly (2011, 2012 and 2013) large cross-sectional samples. The cohort members were patients that were observed, by chance, at least two out of the three yearly samples. A second limitation was that the incidence of stroke in the sample was relatively rare (less than 0.5%). Even though the sample is quite large (n= 6,621 patients), the analyses were still likely to have been under powered as evidenced by some of the quite large effects that the authors observed that could not be demonstrated as statistically significant. Another limitation was that some important lifestyle variables like physical activity, sodium intake, alcohol-, carbohydrate-, and sugar-consumption were not included. The progression of chronic diseases such as HTN is also strongly associated with patients' self-management. The authors had no measure of this in the dataset. Finally, the authors also observed some data quality issues including many missing values in the dataset, although the authors did assess the impact of missing value bias in the analysis.

There were also some major strengths of the study. Firstly, this study was based on a large multicenter, nationwide, cohort dataset. Furthermore, the authors demonstrated that patients in the cohort were representative of the HTN outpatient populations in Thailand. A further strength of the current study was the methodological approach employed. The authors employed models that were able to model repeated measurements of binary outcomes (any stroke) that can deal with both missing values and the 'center' clustering effect.

Recommendations

Despite not being able to demonstrate many QoC indicators as statistically significant, the authors observed large effect sizes and the non-significance of QoC indicators is more likely to reflect the low incidence of stroke in the study period rather than a lack of importance of patient QoC. The large effect sizes observed are strongly indicative despite the lack of statistical significance. Future studies of the impact of QoC on stroke incidence among HTN patients will need relatively large cohorts with sufficient follow up time to establish associations.

Conclusions

With a large nationwide, multicenter, cohort, the study demonstrates that FPG examination led to a substantial reduction in the incidence of stroke. Although we could not demonstrate it as statistically significant, patients attending SHCs in the sample had a substantially lower risk of any stroke.

This finding has important implications for policy makers. HTN patients should increase FPG examination (every two months for HTN patients who are smokers) and should add HbA1C examination annually to the HTN protocol. Key future strategies may involve the use of electronic health records of all HTN patients to improve QoC.[29]

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