文獻綜述 Literature Review

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The association between smoking and secondary or recurrent stroke: A systematic review

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[Abstract] Objective: The objectives of this study was to examine the association between continued smoking and secondary/recurrent stroke. Methods: Scientific articles published prior to February 2018 on smoking and secondary stroke were reviewed. PubMed and China National Knowledge Internet databases were used for literature searches, using the following key terms: "stroke", "cerebral vascular accident", "smoking", "tobacco use", "smokeless tobacco use", "secondary stroke", "repeat stroke", "second stroke". Results: Nine studies were retrieved and analyzed. All studies included patients with ischemic stroke. The rates of smoking among patients with a recurrent stroke ranged from 14% to 84%. There was a relationship between current smoking and an increased risk for a secondary stroke. No difference was found in the risk for a subsequent stroke between quitters and continued smokers. Conclusions: The findings of this review infer that continued smoking is related to an increased risk for a recurrent/secondary stroke, especially among ischemic stroke patients. The findings stress the important role of nurses in educating patients and other health care providers about the relationship between smoking cessation and stroke prevention. Furthermore, this review highlights the role of nurses to advocate for tobacco control policies and smoking cessation support, which will help reduce the risk of primary or secondary stroke.

[Key Words] stroke tobacco use systematic review prevention

腦卒中複發與持續吸煙關係的系統評價

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【摘要】目的：研究持續吸煙與腦卒中複發的關係。方法：以“腦卒中”、“腦血管意外”、“吸煙”、“二次卒中”、“中風”、“中風複發”的中英文為關鍵字檢索 PubMed 和中國知網資料庫於 2018 年 2 月前發表的相關文章，制定納入和排除文獻標準。結果：納入 9 篇文獻進行系統評價。文獻中的研究對象均為缺血性腦卒中患者，卒中複發患者吸煙率為 14%~84%；持續吸煙可增加卒中複發的風險，但是，卒中複發的概率在已戒煙的腦卒中患者與持續吸煙的腦卒中患者間沒有明顯差異性。結論：持續吸煙會增加卒中複發的可能性，尤其是在缺血性腦卒中患者中。護士應加強對腦卒中患者及其他健康照護人員的關於戒煙與腦卒中預防間關係的健康教育。同時，護士應致力於控煙政策及戒煙支持工作，這將有助於降低腦卒中的發生。

【關鍵詞】 腦卒中 吸煙 系統評價 腦卒中預防

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1 Background

As a leading cause of death globally, stroke mortality was estimated at nearly 12% worldwide in 2015 (Benjamin et al., 2018). As the fifth leading cause of death in the US, 133,000 deaths occur from stroke annually (Benjamin et al., 2018). Over all, the cumulative stroke-related healthcare costs from inpatient and outpatient hospital visits, therapy, medication treatments, and long term care is exorbitant. From 2013 to 2014, total direct costs for strokes were $23.6 billion and indirect costs resulting from lost productivity/ mortality were $16.5 billion in the US (Benjamin et al. , 2018). Therefore, it is important to understand the risk factors for stroke to adequately prevent and intervene for this disease.

Stroke involves a disruption in the brain, retina, or spinal cord function that lasts longer than one day, usually determined by imaging (CT or MRI) or an autopsy that indicates infarction or hemorrhage (Sacco et al., 2013). Several factors are associated with the risk of having a stroke, such as genetic, hypertension, hypercoagulability, tobacco use, and excessive alcohol use (O'Donnell et al., 2016). A secondary stroke, or "recurrent stroke" is a stroke that occurs after the initial event (Kernan et al., 2014). Poor knowledge and inadequate prevention of risk factors can result in severe disability, including a recurrence of stroke after the initial. Indeed, among those with a previous stroke, approximately 30% will have a re-occurrence (Rothwell et al., 2004). Recurrent strokes can result in longer hospitalizations, worsened functional outcomes, and higher mortality (Hankey et al., 2002).

The American Heart Association/American Stroke Association (AHA/ASA) guidelines have recommended strategies to prevent strokes based on modifiable risk factor management (Kernan et al., 2014). Among these guidelines, stopping smoking is a high priority. Smoking contributes to 20.7% of stroke-related disability-adjusted life years world-wide (Feigin et al., 2016). In fact, the AHA/ASA secondary stroke prevention guidelines list smoking cessation as a Class 1 level of evidence (i.e., highest level of evidence indicating effectiveness) for stroke prevention. Without properly addressing smoking among stroke patients, there is an increased risk for a second stroke after the initial.

In contrast to the extensive research examining smoking and primary stroke, data on the relationship between continued smoking and recurrent stroke is limited. Continued smoking related to the recurrence of myocardial infarction (Zhang et al., 2015), worsening chronic obstructive pulmonary disease (COPD) (Strulovici-Barel et al. 2016), and poor recovery from cancer treatment (Warren et al., 2013). However, it is not well documented on how continued smoking may impact the recurrence of a stroke. Examining the relationship between continued smoking after an initial stroke and subsequent strokes will provide important information for strengthening practice and evidence-based guidelines.

The purpose of this study was to conduct a systematic literature review on the relationship between continued smoking and the risk for a subsequent or recurrent stroke. Two research questions guided our review:

1) What are the proportions of those with a secondary/ recurrent stroke who are smokers?

2) What is the relationship between continued smoking and the recurrence of a stroke among those with an initial stroke?

2 Methods

2.1 Search strategy

Published articles in the English and Chinese languages, which described the relationship between smoking and secondary stroke, through PubMed electronic database and China national knowledge Internet Database, were assessed. This study did not have a published review protocol. Smoking or tobacco use was defined as any use of combustible or non-combustible tobacco products. Recurrent stroke was defined as having a diagnosed stroke after an initial event. We used the following key terms: "stroke",

"cerebral vascular accident", "smoking", "tobacco use", "smokeless tobacco use", "secondary stroke", "epeat stroke"", "second stroke". We only included studies with well-defined measures of smoking or tobacco use status and the key outcome variables.

2.2 Inclusion and exclusion criteria

Included articles were peer-reviewed, published in English or Chinese, and had been published prior to February 2018. Excluded studies were other systematic reviews or meta-analyses; however, the references used in reviews or meta-analyses were also assessed for relevance. Further studies were excluded if they did not specify a relationship between smoking/tobacco use and secondary stroke; or only examined the relationship between smoking and primary stroke. An additional study by Topcuoglu et al. 2017 was excluded because it did not clearly delineate between primary and secondary stroke symptoms.

2.3 Search outcomes

Initially, 1160 articles were searched from these databases. After reading titles and abstracts, 235 articles were eligible. When removing duplicates, 138 were eligible for further screening, and 97 studies were subsequently reviewed. Finally, 9 studies which met our criteria for eligibility were finally selected. Figure 1 illustrates a diagram depicting the process for identifying and selecting articles.

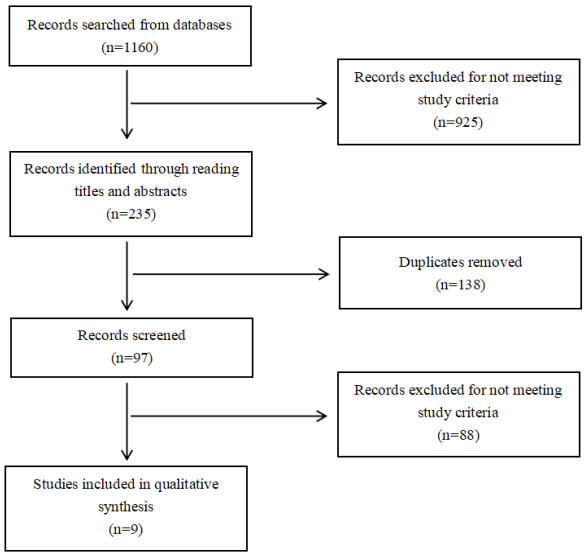

Figure1 Flow diagram of the process used to identify articles for the systematic review

2.4 Quality appraisal and data synthesis

We used an appraisal checklist by Kmet, Lee, and Cook (2004) to examine the quality of our selected studies. This checklist includes 11 items which are scored from 0 to 2 based on meeting specific criteria of robustness for quantitative studies. The total score, per study, could range from 0 to 22. Two reviewers independently scored the articles and achieved an interclass correlation coefficient of pearson r =0.83. The mean quality score for the studies was 19.9 (SD =2.9). In addition, we used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to guide the protocol and reporting of the study (please see PRISMA Checklist in Appendix).

3 Results

3.1 Description of studies

The 9 studies from our search, consisted of a population of 5,323 people with secondary stroke and 1,074 people with or without secondary stroke. Of those with secondary stroke, one study represented populations from seven countries (Epstein et al., 2017), two studies were from populations in China (Zhang et al., 2014; Zhang et al., 2017), and the remaining 4 studies had populations from the USA (Kaplan et al. 2005), Italy (Toni et al., 2014), Belgium (Laloux, Lemonnier, & Jamart, 2010), and Poland (Nowacki et al., 2007). Among the two studies that compared smoking and recurrent stroke, one study was from Spain (Alvarez et al., 2011) and the other from China (Xu et al., 2007). The populations examined in all studies had an ischemic stroke. A description of the included studies in terms of their design, measures, and key findings is in Table 1.

Four studies used a prospective cohort design (Alvarez et al., 2011; Epstein et al., 2017; Kaplan et al. , 2005; Xu et al., 2007), three studies used a retrospective cohort design (Laloux et al., 2010; Nowacki et al., 2007; Zhang et al., 2017), one study used a case-control design (Zhang et al., 2014), and the final study used a retrospective design to analyze secondary data from a

factorial design study (Toni et al., 2014). Six studies were among people with general ischemic stroke (Kaplan et al., 2005; Laloux et al., 2010; Nowacki et al., 2007; Toni et al., 2014; Xu et al., 2007; Zhang et al., 2017), and the other studies had populations of patients specifically with insulin resistance (non-diabetic) with a recent ischemic stroke (Epstein et al., 2017), acute cerebral infarction (Zhang et al., 2014), and cerebrovascular artery disease (which manifested as ischemic stroke) (Alvarez et al., 2011). Five studies categorized smokers into current vs. former and/or never (Kaplan et al., 2005; Laloux et al., 2010; Toni et al., 2014; Xu et al., 2007; Zhang et al., 2017), two studies examined difference between quitters and continuing smokers (Alvarez et al., 2011; Epstein et al., 2017), one study included only light smokers (Zhang et al., 2014), and the final study examined only heavy smokers (Nowacki et al., 2007). The time periods for determining recurrent stroke varied between studies. Two studies examined the recurrence of a stroke within a year of the initial stroke (Xu et al., 2007; Zhang et al., 2017), two studies examined the development of a subsequent stroke between three to five years (Alvarez et al., 2011; Epstein et al., 2017), three studies retrospectively examined the occurrence of a recurrent stroke within a 2.5 to 4-year time period (Laloux et al., 2010; Nowacki et al., 2007; Toni et al., 2014), one study prospectively examined the occurrence of a recurrent stroke within a ten year time period (Kaplan et al., 2005),

Table 1 Description of selected studies

Authors, Year	Type of study	Sample (country)	Measures	Main outcomes
Katherine A. Epstein, et al., 2017	Prospective Cohort Study	Insulin-resistant, nondiabetic patients with a recent ischemic stroke or TIA. (7 countries) N=1,072, (Quitters=450, continuing smokers=622)	Smoking status Quitters (quit after the index event and not smoking at study entry), or continuing smokers. Recurrence of stroke (ischemic or hemorrhagic) Assessed after a median follow-up of 4.8 years.	66.3% of those with recurrent stroke were continuing smokers. Recurrent stroke had occurred in 6.8% (31/450) patients in the quitter group and in 9.8% (61/622) in the continuing smokers group.
Qian Zhang, et al., 2017	Retrospective study	Patients with non-cardioembolic ischemic stroke. (China) N=1,792 (current smokers=1,066; never smokers=726)	Smoking status Current smokers were defined as smoking at least 1 cigarette per day during the month before hospital admission. Never-smokers had never smoked. Secondary ischemic stroke (IS) Stroke patients were evaluated at the time of admission and were continuously assessed every month until 12 months post-stroke according to local clinical stroke protocol.	-Current smokers had significantly higher rates of secondary ischemic stroke than never-smokers (4.3% vs.1.2%, p<0.0001). So, 83.6% of those who had secondary ischemic stroke were current smokers.
Danilo Toni, et al., 2014	Secondary analysis of factorial design study (retrospective cohort study).	Ischemic stroke patients with stroke recurrence. (Italy) N=1794, by stoke subtype LAA=574, CE=52, SAO=846, OE=37, UE=285.	Smoking Status Tobacco use (current vs former/never). Recurrent stroke Assessed for a mean duration of 30 months. Recurrent strokes were classified by causes: due to large artery atherosclerosis (LAA), small artery occlusion (SAO), cardioembolism (CE), other etiology (OE), and undetermined etiology (UE).	-Tobacco users were 25% times more likely to have a recurrent stroke as compared to non-tobacco users among those with SAO (OR=1.25, 95% CI (1.06-1.47, p<0.05). No relationship between tobacco use and other stroke subtypes.

Table 1 Description of selected studies

Fuqing Zhang, et al., 2014	Case-control study	Patients who had acute cerebral infarction. (China) Relapse ACI N= 75	Smoking status Smoking (Yes/No). However, the study excluded heavy smokers (smoked more than 10 cigarettes per day). Acute cerebral infarction (ACI) Patients with ACI within 72 hours diagnosed according to the Chinese Medical Association criteria and verified by computerized tomography or magnetic resonance imaging. Stroke subtypes were categorized into large artery atherosclerosis (LAA), small artery occlusion (SAO), cardioembolism (CE), other etiology (OE), and undetermined etiology (UE).	40% (30/75) of those who had an ACI relapse were smokers.
Alvarez, L. R. et al., 2011	Prospective Cohort Study	Outpatients with Cerebrovascular artery disease (manifesting as ischemic stroke). (Spain) N=240	Smoking Status Active smoking (Yes/No). Recurrent cerebral ischemic event A subsequent ischemic event within a two year and eight-month time period (June 2005 to February 2008). Stroke subtypes were categorized into large vessel disease (LVD), small vessel disease (SVD), embolism (CE), other etiology (O), and undetermined etiology (U).	There were no rate differences between quitters and persistent smokers in incidence of subsequent ischemic stroke [quitters 4.02(1.63-8.37), persistent 1.64 (0.42-4.45)].
P. Laloux, et al., 2010	Retrospective Study	Patients who had a previous history of ischemic stroke or transient attack. (Belgium) N=168	Smoking Status Active smoking (Yes/No). Recurrent cerebral ischemic event A subsequent ischemic event within a two year and eight-month time period (June 2005 to February 2008). Stroke subtypes were categorized into large vessel disease (LVD), small vessel disease (SVD), embolism (CE), other etiology (O), and undetermined etiology (U).	There were no rate differences between quitters and persistent smokers in incidence of subsequent ischemic stroke [quitters 4.02(1.63-8.37), persistent 1.64 (0.42-4.45)].
Gelin Xu, et al., 2007	Prospective Cohort Study.	Adult patients with first-ever ischemic stroke. (China) N=834	Smoking status non-smoker vs former smoker vs current smoker. Recurrence stroke Having a recurrent stroke within one year of original stroke. Stroke subtypes were categorized into Lacunar, atherothrombolic, cardioembolic, and undetermined.	Compared to nonsmokers, former smokers had higher risk for recurrent stroke [HR=1.30 (0.92-2.11)]; and current smokers had significantly higher risk for recurrent stroke [HR=1.71 (1.18-2.47)]. $p<0.05$.
Nowacki, P., et al., 2007	Retrospective cohort study.	Patients with ischemic stroke. (Poland) N=302	Smoking status Heavy smokers (>20 cigarettes/day). Recurrent stroke A subsequent ischemic stroke within a period of three years and eight months (January 2003 to September 2006).	13.9% of those with recurrent stroke were heavy smokers.
R.C. Kaplan, et al.11, 2005	Prospective cohort study.	Oder adults with first incident ischemic stroke. (USA) N= 120	Smoking status Current smoking (Yes/No). The occurrence of recurrent stroke A subsequent stroke (ischemic or hemorrhagic) within a ten-year time period from original event.	Smoking significantly predicted recurrent stroke (HR=2.06, 95% CI 1.19-3.56, $p<0.05$)

and the final case-control study examined the proportion of people who had an acute cerebral infarction within 72 hours of admission to a hospital among those with a previous stroke (Zhang et al., 2014).

3.2 Main outcomes

Due to the heterogeneity between studies the main outcomes are described based on the type of design employed. As such, the main outcomes are grouped into retrospective/case-control and prospective study results.

3.2.1 Retrospective/case-control study findings

The rates of smoking among those with a recurrent stroke varied among studies. In a study with 302 recurrent stroke patients, Nowacki et al. (2007) reported that 14% were heavy smokers. Laloux et al. (2010) examined 168 recurrent cerebral ischemic events and found that 25% were active smokers. Zhang et al. (2014) assessed 75 patients with a recurrent acute cerebral infarction in China, and found that 40% were light smokers. Zhang et al. (2017) examined 55 patients with recurrent ischemic stroke in China, and reported that 84% were current smokers. Moreover, smoking had a strong association with recurrent stroke in two retrospective design studies. Among patients with ischemic stroke (n=846) in Italy, Toni et al. (2014) reported that tobacco users were significantly 25% times more likely to have a small artery occlusion as compared to non-tobacco users; however, no relationship was found between tobacco use and other subtypes of stroke. Among 1,792 patients with non-cardioembolic ischemic stroke in China, Zhang et al. (2017) also found that current smokers had higher rates of secondary ischemic stroke than never-smokers (4.3% vs 1.2%). Therefore, among these studies, current smoking is an associated risk factor for secondary stroke.

3.2.2 Prospective study findings

In the four prospective cohort design studies, two found no difference between quitters and continuing smokers in the occurrence of secondary stroke, and two indicated that smoking was a predictive factor for a recurrent stroke. In a multi-country study of 1,072 insulin-resistant, non-diabetic patients with a recent ischemic stroke or TIA, Epstein et al. (2017) found that a recurrent stroke within five years of the initial, had occurred in 6.8% of quitters as compared to 9.8% of those who continued smoking; but the difference in proportions was not significant. Similarly, among 240 ischemic stroke patients in Spain, Alvarez et al. (2011) reported no significant rate differences between nonsmokers as compared to quitters or persistent smokers in the occurrence of an ischemic stroke within three years of the initial [cumulative incidence (CI): quitters=4.02 (1.63-8.37) vs. persistent smokers=1.64 (0.42-4.45)]. However, in a study among 120 older adults with secondary stroke in the U.S., Kaplan et al. (2005) found that smoking was significantly associated with twice the likelihood of having a recurrent stroke within a ten-year observation period. Also, in a study with 834 first-ever ischemic stroke patients in China, Xu et al. (2007) found that as compared with non-smokers, current smokers were 71% significantly more likely to have a recurrence of a stroke within one year of an initial; but former smokers did not differ in likelihood for a recurrent stroke as compared to nonsmokers. Hence, from two prospective studies we cannot fully concluded that quitting smoking significantly reduces the risk for a recurrent stroke. Yet, from two prospective studies we may conclude that continued smoking significantly increases the risk for a subsequent stroke.

4 Discussion

The purpose of this systematic literature review was to examine the relationship between continued smoking and the risk for secondary/recurrent stroke. In general, among the nine reviewed studies, the rate of smoking was varied in those with secondary stroke, and the risk of a recurrent stroke was influenced by smoking status. Despite the heterogeneity between studies, the findings may be sufficiently consistent to provide some practice recommendations regarding prevention of secondary stroke among those who have an initial stroke.

We found that the rates of smoking varied among those who had a secondary/recurrent stroke, from 14%

(Nowacki et al., 2007) to 84% (Zhang et al., 2017). Among those with a primary stroke, smoking rates have ranged from 30% to 62% (Tsai, Anderson, Thomas, & Sudlow, 2015; Wang et al., 2017; Zhang et al., 2017). The variation in the rates of smoking among those with secondary stroke in our study may be due to differences in tobacco product use and consumption. For example, the samples in our study were different types of smokers, such as heavy smokers (Nowacki et al. 2007), light smokers (Zhang et al., 2014), or current smokers (Zhang et al., 2017). The occurrence of a primary stroke has been linked in a dose-dependent manner to the amount of tobacco product consumption (Hackshaw et al., 2018; Shah & Cole, 2010). The unavailability of information on the amounts of tobacco products consumed by the samples in the different studies hampered our ability to examine the dose response effect between tobacco use and secondary stroke. This information could have assisted in explaining the variability in the rates of smoking among those who had a secondary/recurrent stroke. Future studies may examine the effect of amount of tobacco products consumption on secondary stroke.

In addition, two retrospective (Toni et al., 2014; Zhang et al., 2017) and two prospective studies (Kaplan et al., 2005; Xu et al., 2007) from our review found a strong association between smoking and the risk for a secondary/recurrent stroke. However, two prospective studies (Alvarez et al., 2011; Epstein et al., 2017) found that there were no differences between quitters and continued smokers in recurrent stroke. Since smoking is a known risk factor for primary stroke, AHA/ASA guidelines emphasize the importance of smoking cessation for stroke prevention (Kernan et al., 2014). Yet, it is not clear from our review whether quitting smoking is effective in minimizing the risk of a secondary stroke when compared to continued smoking in patients with stroke. For example, Epstein et al. (2017), deriving their sample from patients with insulin-resistance non-diabetes, found that quitters were proportionately less likely to have a recurrent stroke than current smokers, but the difference was not statistically significant. In contrast, Xu et al. (2007) found that there was a slightly elevated risk for the recurrence of stroke among former-smokers as compared to non-smokers, but this difference was not statistically significant either. Hence, more studies may be needed to provide stronger conclusions about the benefit of quitting smoking after a primary stroke on the risk for a secondary stroke.

Another noteworthy finding was that the risk for recurrent stroke may differ by stroke-subtype. One study (Toni et al., 2014) found that the relationship between smoking and recurrent stroke was only significant in small arterial occlusion ischemic stroke subtype as compared to other subtypes. Since no other studies in our review examined the relationship between smoking and recurrent stroke among different stroke subtypes, it may be premature to conclude that subtypes of stroke may mediate this relationship. This is especially true given that all the reviewed studies were in ischemic stroke patients. It may be important to further explore the relationship between smoking and recurrent stroke among both ischemic and hemorrhagic stroke subtypes.

This systematic review provides some important directions for secondary/recurrent stroke prevention. Most importantly, in addition to modifying stroke-related risk factors (such as poor high salt diet, sedentary lifestyle, excessive alcohol use), education about the relationship between smoking cessation and stroke risk/prevention should be provided to both patients and healthcare providers. Quitting smoking can reduce overall primary stroke risk to an estimated 60% (Shah and Cole, 2010); also, one year after quitting, the risk for stroke among a smoker reduces to about 50%, and 5 years after quitting, stroke risk becomes the same as a non-smoker (Boehme, 2017; Song & Cho, 2008). If a primary stroke patient continues smoking, he or she may have a 23% probability for a secondary/recurrent stroke, myocardial infarction, or death within 5 years, which is higher than one who quits smoking (16%) (Epstein et al., 2017). In addition, healthcare providers should give a high priority to following up with stroke patients on their smoking status and making it a part of

stroke extended care. Practically, this may mean that at discharge patients who use tobacco should be provided a referral to tobacco treatment programs or offered tobacco cessation medications (Fiore et al., 2008). Seventy-percent of smokers are willing to quit, and within 30 days of relapse, two thirds of smokers would like to try another quit attempt (Fiore et al., 2008). However, those who quit still have a high risk of relapse for several months or years after quitting (Fiore et al. ,2008). All of these findings in the literature suggest that healthcare providers should keep frequent contact with recent quitters and provide advice to quit for those who still smoke after a stroke.

Another important aspect of enhancing primary or secondary stroke prevention, in relationship to smoking, is the training of nurses in brief smoking cessation interventions at point-of-care. According to the U.S. clinical practice guidelines for treating tobacco use and dependence, advice to quit by a health care professional significantly increases the odds of a patient quitting by 30% (Fiore et al., 2008). However, to increase the skill set and competence of nurses to engage patients in smoking cessation, they require training on evidence-based approaches. A key evidence-based approach includes the "5 As for smoking cessation" in which nurses can be trained to Ask patients about tobacco use, Advise them to stop, Assess their readiness to engage in cessation, Assist them in their cessation efforts by providing behavioral counseling and smoking cessation medications, and Arrange for them to be followed up in their progress or refer them to a program in their community (Fiore et al., 2008). Depending on the clinical setting, variations of the 5A's for smoking cessation, which include the 4A's (Ask, Advise, Assist, Arrange)(West, McNeill, & Raw, 2000) or the 2A's and R (Ask, Advise, Refer)(Schroeder, 2005) may be more appropriate. Moreover, nursing school curricula may incorporate tobacco treatment training for nursing students in preparation for practice (Petersen et al., 2017; Schwindt, McNelis, & Agley, 2016). Training on evidence based tobacco treatment is associated with increased confidence, skills and delivery of tobacco treatment (Carson et al., 2012; Sheffer, Barone, & Anders, 2011).

To strengthen the impact of our practice and education recommendations, we need to consider important policy strategies from the clinical, hospital, and governmental sectors. From the clinical sector, U.S. Clinical Practice Guidelines advocate for hospital-level policies that develop a process of systematically monitoring and treating tobacco use among patients (Fiore et al., 2008). In addition, hospital accreditation bodies have an important role in ensuring that tobacco control policy initiatives are adopted and enforced. For example, in the U.S. and Canada, accreditation bodies for hospitals require that hospital grounds be tobacco-free as a part of being an accredited hospital entity (Luck, 2016; Ortiz & Schacht, 2015); such policies are associated with increased tobacco treatment delivery (Gadomski, Stayton, Krupa, & Jenkins, 2010; McCrabb et al., 2017). Similarly, governmental bodies can play significant roles in increasing the requirement of tobacco treatment as part of reimbursed hospital care by incentivizing the adoption of treatment. For example, in the United Kingdom, the National Health Services has incentivized the documentation of tobacco treatment in general practice settings (Taggar, Coleman, Lewis, & Szatkowski, 2012). Also, the U.S. Centers for Medicaid and Medicare has required certain health institutions to report compliance with tobacco treatment measures as a means for receiving reimbursement for patient care (Medicare & Services, 2015). Integrating such measures in institutions that provide care for stroke patients can incentivize smoking cessation provision. In fact, inpatient smoking cessation treatment can be successful in assisting patients to quit after discharge as demonstrated among a Korean cohort (Ha et al., 2016). Nurses should advocate for such strategies in their health care settings to both enhance tobacco treatment delivery and reduce the normative nature of tobacco use among the patients for whom they care.

A few important limitations need to be considered in drawing conclusions from our review. First, just four prospective studies were included in our review;

hence, causal inferences need to be made judiciously. More prospective studies are required in the future to examine the effect of continued smoking on secondary/recurrent stroke. Second, in the studies retrieved from our literature search, the sample populations, definitions of smoking status, and assessment time-frames for detecting a secondary/recurrent stroke varied. As a result, differences in the samples obtained and designs of the studies, which precluded meta-analytic techniques, may have affected the findings. Third, all the samples in the retrieved studies were derived from patients with ischemic stroke; thus, the findings may not be generalized to patients with hemorrhagic strokes. Finally, smoking status in all the reviewed studies were based on self-reports with no biochemical assessment of tobacco use. More research using valid tobacco use assessments (e.g., saliva cotinine, expired carbon monoxide readings), where feasible, can enhance the confidence in understanding the relationship between smoking and secondary/recurrent stroke.

5 Conclusion

Smoking rates among patients with a secondary stroke can be high and continued smoking is associated with an increased risk of a recurrent/secondary stroke, especially among ischemic stroke patients. The findings of our review suggest that more studies are needed to apprehend the increased risk for a secondary/recurrent stroke among different subtypes of stroke, particularly hemorrhagic stroke. Nonetheless, for primary and secondary stroke prevention, nurses have an important role in educating patients and other health care providers about risks, getting trained in tobacco treatment, and advocating for policies that increase the access to and delivery of tobacco use cessation for patients. Adopting sound tobacco treatment practices and advocating for reliable tobacco control policies can support health promoting behaviors to reduce the risk for developing primary and secondary stroke. Nurses continue to play an important role in primary and secondary stroke prevention, of which smoking remains a key modifiable risk factor.

References

Alvarez, L.R., Balibrea, J.M.,Surinach, J.M., Coll, R., Pascual, M.T., Toril, J., ...Monreal, M.(2011). Smoking cessation and outcome in stable outpatients with coronary, cerebrovascular, or peripheral artery disease. *European Journal of Preventive Cardiology, 20*(3), 486-495. doi: 10.1177/1741826711426090

Benjamin, E,J., Virani, S.S., Callaway, C.W., Chamberlain, A.M., Chang A.R., Cheng, S., ...Muntner, P.. (2018). Heart disease and stroke statistics-2018 update: A report from the American Heart Association. *Circulation, 137*(12), e67-e492. doi:10.1161/cir.0000000000000558

Boehme, A. (2017). Smoking cessation and secondary stroke prevention. *Neurology, 89*(16), 1656-1657. doi:10.1212/wnl.0000000000004530

Carson, K.V., Verbiest,M.E., Crone, M.R., Brinn, M.P., Esterman, A.J., Assendelft, W.J., & Smith, B.J. (2012). Training health professionals in smoking cessation: A cochrane systematic review. *Respirology, 17*, 20. doi: 10.1002/14651858

Epstein, K.A., Viscoli, C.M., Spence, J.D., Young, L.H., Inzucchi, S.E., Gorman, M., ...Kernan, W.N. (2017). Smoking cessation and outcome after ischemic stroke or TIA. *Neurology, 89*(16), 1723-1729. doi: 10.1212/WNL.0000000000004524

Feigin, V.L., Roth, G.A., Naghavi, M., Parmar, P., Krishnamurthi, R., Chugh, S., ...Forouzanfar, M.H. (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. *Lancet Neurology, 15*(9), 913-924. doi:10.1016/s1474-4422(16)30073-4

Fiore, M., Jaen, C.R., Baker, T.B., Bailey, W.C., Bennett, G., & Benowitz, N.L. (2008). Treating tobacco use and dependence: 2008 clinical practice guidelines. Rockville: US Department of Health and Human Services. *Public Health Service*, 1196-1199. doi:10.1016/j.amepre.2008.04.009

Gadomski, A.M., Stayton, M., Krupa, N., & Jenkins, P. (2010). Implementing a smoke free medical campus: Impact on inpatient and employee outcomes. *Journal of Hospital Medicine, 5*(1), 51-54. doi: 10.1002/jhm.473

Ha, E., Jo, J.Y., Ahn, A.L., Oh, E.J., Choi, J.K., Cho, D.Y., & Kweon, H.J. (2016). Predictors of successful smoking cessation after inpatient intervention for stroke patients. *Korean journal of family medicine, 37*(2), 85-90. doi:

10.4082/kjfm.2016.37.2.85

Hackshaw, A., Morris, J.K., Boniface, S., Tang, J.L., & Milenkovic, D. (2018). Low cigarette consumption and risk of coronary heart disease and stroke: Meta-analysis of 141 cohort studies in 55 study reports. *British Medical Journal, 360*, j5855. doi:10.1136/bmj.j5855

Hankey, G.J., Jamrozik, K., Broadhurst, R.J., Forbes, S., & Anderson, C.S. (2002). Long-term disability after first-ever stroke and related prognostic factors in the Perth Community Stroke Study, 1989-1990. *Stroke, 33*(4), 1034-1040. https://doi.org/10.1161/01.STR.0000012515.66889.24

Kaplan, R.C., Tirschwell, D.L., Longstreth, W.T., Manolio, T.A., Heckbert, S.R., Leffkowitz, D., ...Psaty, B.M. (2005). Vascular events, mortality, and preventive therapy following ischemic stroke in the elderly. *Neurology, 65*(6), 835-842. doi:10.1212/01.wnl.0000176058.09848.bb

Kernan, W.N., Ovbiagele, B., Black, H.R., Bravata, D.M., Chimowitz, M.I., Ezekowitz, M.D., ...Wilson, J.A. (2014). Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: A guideline for healthcare professionals from the American Heart Association/ American Stroke Association. *Stroke, 45*(7), 2160-2236. doi:10.1161/str.0000000000000024

Kmet, L., Lee, R., & Cook, L. (2004). Standard quality assessment criteria for evaluating primary research papers from a variety of fields. Alberta Heritage Foundation for Medical Research. Retrieved from https://era.library.ualberta.ca/items/48b9b989-c221-4df6-9e35-af782082280e

Laloux, P., Lemonnier, F., & Jamart, J. (2010). Risk factors and treatment of stroke at the time of recurrence. *Acta Neurolgica Belgica 110*(4), 299-302. doi:10.1021/cn100083a

Luck, K. (2016). Are Canadian hospitals leading by example to promote smoke-free hospital properties? Rationale, challenges and opportunities. *Journal of Hospital Administration, 5*(4), 9. doi: https://doi.org/10.5430/jha.v5n4p9

McCrabb,S., Baker, A.L., Attia, J., Balogh, Z.J., Lott, N., Palazzi, K, ...Bonevski, B. (2017). Hospital smoke-free policy: Compliance, enforcement, and practices. A staff survey in two large public hospitals in Australia. I*nternational Journal of Environmental Research and Public Health*, 14(11), 1358. doi: 10.3390/ijerph14111358

Centers for Medicare & Medicaid Services (2015). *Inpatient psychiatric facility quality reporting program manual*. Baltimore, MD: Centers for Medicare & Medicaid Services.

Nowacki, P., Porebska, A., Bajer-Czajkowska, A., Zywica, A., Koziarska, D., & Podbielski, J. (2007). An approach of patients with ischemic stroke to primary and secondary stroke prevention in Poland. *Annales Academiae Medicae Stetinensis, 53*(2), 14-19. doi:10.1111/j.1368-423X.2007.00209.x

O'Donnell, M.J., Chin, S.L., Rangarajan, S., Xavier, D., Liu, L., Zhang, H., ...Yusuf, S. (2016). Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): A case-control study. *Lancet, 388*(10046), 761-775. doi:10.1016/s0140-6736(16)30506-2

Ortiz, G., & Schacht, L. (2015). Smoking ban implementation in psychiatric inpatient hospitals: Update and opportunity for performance improvement. *Journal of Family Medicine, 2*(5), 1039.

Petersen, A.B., Meyer, B., Sachs, B.L., Bialous, S.A., & Cataldo, J.K. (2017). Preparing nurses to intervene in the tobacco epidemic: Developing a model for faculty development and curriculum redesign. *Nurse Education in Practice, 25*, 29-35. doi: 10.1016/j.nepr.2017.04.005

Rothwell, P.M., Coull, A.J., Giles, M.F., Howard, S.C., Silver,L.E., Bull, L.M., ...Anslow, P. (2004). Change in stroke incidence, mortality, case-fatality, severity, and risk factors in Oxfordshire, UK from 1981 to 2004 (Oxford Vascular Study). *Lancet, 363*(9425), 1925-1933. doi:10.1016/s0140-6736(04)16405-2

Sacco, R.L., Kasner, S.E., Broderick, J.P., Caplan, L.R., Connors, J.J.,Culebras, A., ...Vinters, H.V. (2013). An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/ American Stroke Association. *Stroke, 44*(7), 2064-2089. doi:10.1161/STR.0b013e318296aeca

Schroeder, S. A. (2005). What to do with a patient who smokes. *Journal of the American Medical Association, 294*(4), 482-487. doi:10.1001/jama.294.4.482

Schwindt, R., McNelis, A., & Agley, J. (2016). Curricular innovations in Tobacco Cessation Education for Prelicensure Baccalaureate Nursing Students. *Journal of Nursing Education, 55*(8), 425-431. doi:10.3928/01484834-20160715-02

Shah, R., & Cole, J. (2010). Smoking and stroke: the more you smoke the more you stroke. *Expert Review of Cardiovascular Therapy, 8*(7), 917-932. doi:10.1586/erc.10.56

Sheffer, C., Barone, C., & Anders, M. (2011). Training nurses in the treatment of tobacco use and dependence: pre and post training results. *Journal of Advanced Nursing, 67*(1), 176-183. doi:10.1111/j.1365-2648.2010.05483.x

Song, Y., & Cho, H. (2008). Risk of stroke and myocardial infarction after reduction or cessation of cigarette smoking: A cohort study in korean men. *Stroke, 39*(9), 2432-2438. doi:10.1161/strokeaha.107.512632

Strulovici-Barel, Y., Staudt, M.R., Krause, A., Gordon, C., Tilley, A.E.,Harvey, B.G., ...Crystal, R.G. (2016). Persistence of circulating endothelial microparticles in COPD despite smoking cessation. *Thorax, 71*(12), 1137-1144. doi:10.1136/thoraxjnl-2015-208274

Taggar, J., Coleman, T., Lewis, S., & Szatkowski, L. (2012). The impact of the Quality and Outcomes Framework (QOF) on the recording of smoking targets in primary care medical records: Cross-sectional analyses from The Health Improvement Network (THIN) database. *BMC Public Health, 12*(1), 329. doi: 10.1186/1471-2458-12-329

Toni, D., Di Angelantonio, E., Di Mascio, M.T., Vinisko, R., & Bath, P.M. (2014). Types of stroke recurrence in patients with ischemic stroke: A substudy from the PRoFESS trial. *International Journal of Stroke, 9*(7), 873-878. doi: 10.1111/ijs.12150

Topcuoglu, M.A., Saka, E., Silverman, S.B., Schwamm, L.H., & Singhal, A.B.. (2017). Recrudescence of deficits after stroke: Clinical and imaging phenotype, triggers, and risk factors. *Journal of the American Medical Association: Neurology, 74*(9), 1048-1055. doi: 10.1001/jamaneurol.2017.1668.

Tsai, C., Anderson, N., Thomas, B., & Sudlow, C. (2015). Risk factors for ischemic stroke and its subtypes in Chinese vs. Caucasians: Systematic review and meta-analysis. *International Journal of Stroke, 10*(4), 485-493. doi:10.1111/ijs.12508

Wang, W., Jiang, B., Sun, H., Ru, X., Sun, D., Wang, L., ...Feigin, V.L. (2017). Prevalence, incidence, and mortality of stroke in China: Results from a nationwide population-based aurvey of 480 687 adults. *Circulation, 135*(8), 759-771. doi:10.1161/circulationaha.116.025250

Warren, G.W., Kasza, K.A., Reid, M.E.,Cummings, K.M., & Marshall, J.R. (2013). Smoking at diagnosis and survival in cancer patients. *International Journal of Cancer, 132*(2), 401-410. doi:10.1002/ijc.27617

West, R., McNeill, A., & Raw, M. (2000). Smoking cessation guidelines for health professionals: an update. *Thorax, 55*(12), 987-999. doi:10.1136/thorax.55.12.987

Xu, G., Liu, X., Wu, W., Zhang, R., & Yin, Q. (2007). Recurrence after ischemic stroke in chinese patients: Impact of uncontrolled modifiable risk factors. *Cerebrovascular Diseases, 23*(2-3), 117-120. doi:10.1159/000097047

Zhang, F., Li, X., Dong, Q., Wang, Y., & Zhang, H.. (2014). Risk of acute cerebral infarction and plasma asymmetrical dimethylarginine and homocysteine levels: A clinical correlation analysis of Chinese population. *Journal of Stroke and Cerebrovascular Diseases, 23*(9), 2225-2232. doi: 10.1016/j.jstrokecerebrovasdis.2014.04.001

Zhang, F.L., Guo, Z.N., Wu, Y.H., Liu, H.Y., Luo, Y., Sun, M.S., ...Yang, Y. (2017). Prevalence of stroke and associated risk factors: A population based cross sectional study from northeast China. *British Medical Journal Open, 7*(9), e015758. doi:10.1136/bmjopen-2016-015758

Zhang, Q., Wang, Y., Song, H., Hou, C., Cao, Q., Dong, K., ... Ji, X. (2017). Clopidogrel and ischemic stroke outcomes by smoking status: Smoker's paradox? *Journal of Neurological Science, 373*, 41-44. doi: 10.1016/j.jns.2016.12.025

Zhang, Y.J., Iqbal, J., van Klaveren, D., Campos, C.M., Holmes, D.R., Kappetein, A.P., ...Serruys, P.W. (2015). Smoking is associated with adverse clinical outcomes in patients undergoing revascularization with PCI or CABG: The SYNTAX trial at 5-year follow-up. *Journal of the American College of Cardiology, 65*(11), 1107-1115. doi:10.1016/j.jacc.2015.01.014