Contents

1 Stroke Epidemiology

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Abstract
Stroke is one of the leading causes of morbidity and mortality among adults. More than 5 million people a year die of stroke around the world. It is difficult to evaluate incidence, prevalence and mortality on account of differences in registration. Most strokes are ischemic. Women have a higher incidence with a higher lifetime risk. Although the incidence in the high-income countries seems to be decreasing, the total burden of disease has not changed, and in fact may increase in the future, partly on account of an aging population. Transient ischemic attacks often precede stroke. Recurrent stroke is especially frequent after lobar hematoma. Secondary prevention and etiologic treatment have lowered somewhat the incidence of recurrent stroke. Mortality is substantial, both short-term and long-term, but a precise assessment is impossible due to surprising regional variations that are probably due to differences in reporting and registering. Global mortality tends to decrease, probably as a consequence of improved care. Non-modifiable risk factors include age, male sex, African ancestry, family history of stroke and genetic factors. Large vessel disease and cardioembolic stroke associate more frequently in women younger than 65. Modifiable risk factors, which account for 90% of stroke risk, are: hypertension (a major risk), diabetes (across all ages and ethnicities), arrhythmias (particularly if associated to AF and female sex), smoking, chronic kidney disease, oral estrogen therapy, sleep apnea. On consideration of the above, it becomes evident that stroke prevention requires a lifestyle change. Primary care physicians and health policies should cooperate to this end. Only a joint effort can decrease this pandemic significantly.

Keywords: stroke pandemic, ischemic stroke, hypertension, smoking, oral estrogen therapy, lifestyle change

1.1 Introduction

Stroke is one of the leading causes of morbidity and mortality in adults, with an increasing burden of disease in the adult and aging population. Worldwide, an estimated 16 million people per year suffer a stroke, leading to 5.7 million deaths.[1]

These results might be underestimated because of limitations in registry data and healthcare reporting in different countries or lack of access to healthcare in developing countries. Moreover, different studies might have slightly different results because of sample bias, making extrapolations difficult. It very likely that the true burden of disease is much higher, especially in developing countries, hence the need for better records, improved diagnostic algorithms, and faster access to optimum treatment, which are dealt with in other chapters.

Knowledge of the epidemiology of this worldwide pandemic is fundamental for public health policy, prevention strategy development and assessment of effective interventions. In this chapter, we review the current global findings of stroke epidemiology, its trends and associated risk factors.

Stroke epidemiology can be studied in two different ways, descriptive and analytical. Descriptive epidemiology tells us the frequency of the disease, and its changes through time, space and among different populations.[1] On the other hand, analytical epidemiology allows us to identify risk factors for stroke, and predictors of morbidity and mortality.[1] Both are necessary to effectively prevent and treat this disease.

1.2 Descriptive Epidemiology

The main indicators used in stroke descriptive epidemiology are prevalence, incidence, and mortality.

Incidence is the number of new cases in a specific population in a fixed period. This is a dynamic measurement, which can change between different periods of time, places, seasons, and can be affected by our efforts to fight against the specific disease.[1] It is expressed as a function of cases per person-time, and most often as cases per person-years, for a specific population.[1]

Prevalence is defined as the number of people with stroke at a specific moment of time, and represents the total burden at said moment. Prevalence can also be estimated over a period, integrating the incidence, as new cases during the study period, and the length of the disease. The higher the incidence and the longer the duration, the higher the prevalence in each period.[1]

Mortality rates represent the number of deaths in a fixed population over a period. In stroke

epidemiology, both overall mortality and cause-specific mortality (deaths related directly to stroke) are used,[1] which may make interpretations difficult.

1.2.1 Stroke Prevalence

The worldwide prevalence in 2013 was an estimated 25.7 million, with approximately 10.3 million people having a first stroke in that year.[2] Most were ischemic in nature, and about 30% occurred in those younger than 65 years of age.[3] Due to the problems with reporting in different health systems and countries, it is likely that these findings are an underestimation of the real prevalence of stroke. There are, however, large sample studies available, mainly from developed countries, that provide essential information in this area.

Even though some findings suggest that age-adjusted mortality rates for ischemic and hemorrhagic stroke decreased between 1990 and 2013, the total number of strokes, related deaths and disability- adjusted life- years lost, increased.[4] In our opinion, it is very likely that this trend continues today, given the increase in life expectancy in recent years and that stroke prevalence increases with age.[4] Supporting this fact are findings from studies arising from the Behavioral Risk Factor Surveillance System (BRFSS) in the US, which shows that between 2006 to 2010, overall self-reported stroke prevalence did not change.[5]

Furthermore, in a US study of general population without prior diagnosis of stroke or TIA involving 18462 participants, the presence of least one neurologic symptom in those over 45 years old was 17.8%.[6] These findings strongly suggest that the true prevalence of stroke is even higher than estimated, with many undiagnosed or unreported events. These were more frequent in African Americans, those with lower education and income, and those with poor perceived health status,[6] which represent the more vulnerable populations in that country. Limitations in access to healthcare may also play a role in this population segment.

Finally, following worldwide trends, the prevalence of stroke in the US is expected to increase by 20.5% by 2030, compared to 2012.[7] In addition, prevalence of stroke survivors in the ageing population is expected to increase,[8] which will represent an increased challenge to healthcare systems and society as a whole. An optimization of prevention strategies and effective treatments will likely mitigate this expected increase, and might even prove predictions wrong. It is our responsibility as healthcare professionals to advocate for these changes to take place.

1.2.2 Stroke Incidence

Obtaining a global incidence statistic for stroke is a complex endeavor. The actual incidence varies greatly among different geographical regions, populations, and even across time.[1]

Worldwide, in 2010, there were an estimated 11.6 million ischemic strokes and 5.3 million hemorrhagic strokes, with increased incidence in low and middle-income countries.[9] This represents an incidence estimate of 258/100,000 people-year.[10] Between 1990 and 2010 the incidence of ischemic stroke fell by 13% in high income countries, but not in low or middle-income ones.[9] Furthermore, the incidence of hemorrhagic stroke decreased by 19% in high income countries, but increased by 22% in the rest with a higher burden on those 75 years old or younger.[9]

While socioeconomic status and an aging population clearly play a role, we believe that this also reflects the commitment of different countries to prevention and treatment of stroke, and to challenges in global healthcare, which must be addressed in following years to revert this situation.

The worldwide variations in incidence are far reaching across different populations, ranging from 130 to 410/100000 person-years.[1] There are also variations according to stroke subtypes, with the incidence of hemorrhagic stroke being significantly higher in Asian countries than in the Western world. This has been linked to a higher prevalence of hypertension in these populations, although other factors cannot be ruled out.[1]

In the US, about 795 000 people per year experience a new or recurrent stroke, of which approximately 610 000 are first attacks.[4] Of these, 87% are ischemic, 10% are ICH, and the remainder 3% are SAH strokes.[4]

Stroke incidence seems to be higher in those of African descent, with a lower incidence of cerebral infarction in women under 75, irrespective of ethnicity.[4] Among those aged 75 or older, African American women showed a higher incidence of cerebral infarction than men of the same ethnicity, while no difference was observed between white men and women aged 75 to 84.[4]

Women seem to have a higher incidence of stroke than men with a higher lifetime risk than men.[11] In the Framingham heart study, the lifetime risk was about 20% for women between 55 and 75 years of

age, while it was approximately 15% for men of the same group. This seems to be at the expense of an increased incidence in older age groups and longer life span, since age adjusted incidence is lower for females in middle age or younger.[4]

Findings from both the BASIC Project between 2000 and 2010, the Framingham Heart Study, and Medicare recipients in the US show a reduction in incidence of global stroke over time[4] consistent with global findings of decreased incidence in high income countries.[12] Although incidence seems to be decreasing, the total burden of the disease has not changed, and is likely to increase,[1] especially with an aging population[12] and the increased prevalence of risk factors,[13] which we will discuss later in this chapter.

1.2.3 Transient Ischemic Attacks (TIA)

The knowledge of TIA epidemiology has a relevant role in stroke planning and prevention, since it is known that approximately 15% of all strokes are heralded by a TIA.[14] This means that appropriate evaluation, treatment and secondary prevention are mandatory for these patients. Failure to do so exposes them to potentially severe and life-threatening complications, and worsens their prognosis. In the US, it is estimated that that the prevalence of TIA was 2.3% overall, and increased with age. The real number is likely higher though, due to the same caveats of stroke research.[15]

A patient with a TIA is at a significant risk of short term complications, both neurologic and cardiovascular, and has an increased mortality risk. In one study of 1707 TIA patients evaluated in the emergency department in a northern California hospital, 5% had a stroke in the first 48 hours and 11% presented with stroke during the following 3 months. Risk factors for progression to stroke were age over 60 years old, diabetes, and duration over 10 minutes.[16]

Meta-analyses of cohorts of patients with TIA have shown that the risk of stroke in the first 48 hours is between 3% to 10%, and is 9% to 17% for the first three months.[17,18] Stroke risk at 10 years is approximately 19%.[4] Furthermore, the Oxford Vascular Study has shown that TIAs are a significant predictor of disability at 5 years.[19]

1.2.4 Recurrent Stroke

Recurrent stroke is a major complication in stroke survivors, with a major increase in morbidity and mortality. Several studies have assessed its prevalence and incidence, with results up to 18% recurrence rate at 4 years.[4]

Actual recurrence rates vary among different studies. A study in Northern Sweden, which followed 6700 patients who survived an ischemic stroke or had an intracranial hemorrhage between 1995 and 2008, showed that in this population recurrence rates were 6% at 1 year, 16% at year 5, and 25% at year 10 [20]. Another study which followed 10399 patients with a primary stroke in 2002 in the US, showed rates of 1.8% at 1 month, 5% at 6 months, 8% at 1 year, and 18.1% at 4 years.[21]

Recurrence rates vary according to etiology, stroke subtypes, and between studies. For hemorrhagic stroke, recurrence rates have been estimated at 2.4% per year, with a fourfold increase for lobar hematoma.[1] Most recurrences after both hemorrhagic and ischemic stroke are ischemic.[20] For ischemic strokes, rates were higher for those caused by large artery disease followed by small vessel disease and stroke of cardioembolic origin.[4] Also, a larger number of risk factors present is associated with higher recurrence rates.[4] Both diabetes and age at stroke are risk factors associated with increased risk of recurrence,[20] although all comorbidities play a role.

With minor variations, these findings are consistent across multiple studies in multiple populations of first world countries.[4]

In recent years, a decline in recurrence rates has been observed, probably due to better secondary prevention and etiologic treatment.[22,23] This should only strengthen our focus to improve on primary prevention, effective timely treatments and follow up, to reduce stroke's burden and improve outcomes.

1.2.5 Mortality

A recent report on global stroke statistics by Thrift et al[12] surveying all countries associated to the WHO has revealed an astonishing lack of accurate and recent data in over half of them, which makes evaluating true mortality difficult. This report also highlights significant differences between high income countries and low-middle income ones, where mortality adjusted by age seems to be higher, despite being probably underreported.

Mortality in stroke is substantial, both short-term and long-term. It varies significantly according to stroke subtype, being significantly higher for hemorrhagic subtypes in most studies, especially within the first month.[4] Further variances

are observed across different populations, where age-adjusted mortality ranges from 41/100 000 people-years in Nigeria to 316/100 000 person-years in urban Dar-es-Salaam (Tanzania).[12] This large variation in mortality probably responds not only to intrinsic factors of each population, but also to differences in registry keeping and reporting between different countries. These large differences cast doubt on the actual available information. Another unexpected factor is the large difference between incidence and mortality rates in some low and middle-income countries, which are not concordant. There is probably a need for international organizations to directly take representative samples in different healthcare-challenged countries in order to properly assess stroke statistics.

The Atherosclerosis Risk in Communities Study (ARIC) study, which involved US patients from 4 different cities for a period of 24 years, showed a cumulative global mortality after index stroke of 10.5% at 1 month, 21.2% at 1 year, 39.8% at 5 years, and 58.4% at the end of follow up.[4] In the aforementioned Swedish study, a combined endpoint of recurrence and death was 28% at 5 years, and 45% at 10 years.[20] Furthermore, In the US, in 2014, stroke ranked 5th among leading causes of death, with a rate of 36.5/10000. These findings show the importance of secondary prevention and the dreadful long-term outcome a significant number of patients have after stroke.

Global trends suggest a decrease in mortality over the last 30 years of around 25%-30%.[4] This decline in mortality was more noteworthy in those over 65 years old, compared to younger age groups, although some studies show conflicting results in this regard.[24,25] Although the role of primary prevention cannot be discarded, the decrease in mortality has been attributed to improvements in prehospital and in hospital emergent care,[1] which we agree wholeheartedly with.

1.3 Stroke Risk Factors

Stroke risk factors surge from analytic epidemiology, and are an essential part of planning interventions to decrease incidence. These risk factors are usually separated into modifiable and non-modifiable, which helps to differentiate those that can be targets of preventive measures from those that cannot. A properly established risk factor requires multiple studies consistently supporting its association, compatible pathophysiological mechanisms, and ideally randomized controlled trials which show that intervention on these risk factors lowers stroke incidence.[1] Unfortunately, this is not always the case.

Known non-modifiable risk factors include age, male sex, African ancestry, family history of stroke, and genetic factors.[1] There are many modifiable risk factors, such as hypertension, diabetes, obesity, diet, and physical exercise.[1] A recent review of the burden of stroke and its risk factors in 188 countries by Feigin et al strongly suggests that modifiable risk factors account for 90% of total stroke burden, as measured by disability-adjusted life-years lost (DALYs).[13] The main contributors were behavioral risk factors such as smoking, lack of exercise and poor diet, followed by combined metabolic risk factors and pollution.[13] The INTERSTROKE study, a case-control study which followed 26 919 people from 32 countries between 2007 to 2015, also had similar results, showing that 10 modifiable risk factors accounted for 90% of stroke risk irrespective of age and sex.[26] These risk factors were Hypertension (OR 2.98), regular physical activity (0.60), apolipoprotein (Apo)B/ApoA1 ratio (OR 1.84), diet (OR 0.60), waist-to-hip ratio (OR 1.44), psychosocial factors (OR 2.20), smoking (OR 1.67), cardiac causes (OR 3.17), alcohol consumption (OR 2.09), and diabetes mellitus (OR 1.16).[26] We will discuss most major risk factors for stroke in this chapter.

1.3.1 Non-Modifiable Risk Factors

Age is the most important non-modifiable risk factor. It has been estimated that stroke risk doubles every decade after 55 years of age.[1] The increase with age has been consistently demonstrated across all studies to date.

Male sex is a risk factor for ischemic stroke in patients younger than 75 years of age, but not in those older.[4] This is probably due to the increased proportion on women in said age group, which leads to a higher number of cases.[1] For this reason, women also seem to have a higher total lifetime stroke risk.[27] Male sex has also been associated with intracerebral hematoma, whereas female sex is a risk factor for subarachnoid hemorrage.[1]

Those of African ancestry have an increased stroke risk. In the US, the Northern Manhattan Study (NOMAS) has shown an age adjusted incidence of stroke of 1.91/1000 people in blacks versus 0.88/1000 in whites.[28] In addition, in the US, both the NOMAS study and the BASIC project have shown an increased incidence in Mexican Americans.[28,29] Even though those of black race have an increased prevalence of some risk factors which

could explain this association, such as hypertension, direct interpretation is difficult since separating race from socioeconomic status is not possible.[1]

A stroke before age 65 in either parent was associated with a threefold risk increase in offspring in the Framingham Heart Study.[29] This shows that there is a hereditary predisposition in some families. Recent studies suggest that the lower the age at the moment of stroke, female sex, large vessel disease and cardioembolic stroke for ischemic subtypes may have a stronger association.[4] The presence of a stroke on either parent increases the risk by a factor of approximately 2[1].

Some genetic mutations also confer a predisposition to stroke. For ischemic stroke, mutations in *HDAC, ABO, and TSPAN2* genes have been implicated in large vessel origin.[4] Other genes, such as *PTX2 and ZFHX3* have been related to cardioembolic ischemic stroke.[4] *FOXF2* mutations have been strongly related to small vessel disease.[4] Regarding hemorrhagic stroke, genes in the PMF1/BGLAP region have been linked to non-lobar ICH, and changes in Apolipoprotein E with lobar hematoma.[4] Even though these mutations, as well as others that are not currently known, increase stroke risk, familial risk cannot be attributed entirely to it. Other modifiable risk factors that can have an inherited component, such as hypertension or diabetes, as well as dietary habits in the family, certainly have interactions with the genetic component and affect the risk they confer.[1]

1.3.2 Modifiable Risk Factors

As mentioned before, modifiable causes may account for up to 90% of stroke risk[13,26].

1.3.3 Hypertension

The definition of hypertension has changed significantly in the past 20 years, and is still under discussion. Nonetheless, it is beyond discussion at this point that elevated values are a major modifiable risk factor for all stroke types.[4]

Moreover, several studies have shown that blood pressure control leads to reduced stroke risk, especially among patients with other comorbidities such as diabetes.[4] Some studies have also shown a larger benefit with intense blood pressure control, with target systolic pressure below 120 mmHg versus 140 mm Hg.[30] Nonetheless, there is still some disagreement on definitive target BP, and probably further randomized trials are necessary to achieve a definite consensus.

The effect of blood pressure is also variable between different populations. In African Americans, elevated blood pressure is responsible for approximately 20% of the increased stroke rate[31] whereas an increase in 10 mmHg lead to three times the increase in risk as in whites.[32]

1.3.4 Diabetes Mellitus

Diabetes is a significant risk factor across all ages and ethnicities. Furthermore, diabetic patients are likely to have other risk factors, leading to increased risk.[4] Diabetic women seem to have an increased risk compared to men. Prediabetes has also been associated with increased risk, but with a more modest effect.[4]

Diabetic patients are also at increased risk of recurrence.[33] Prognosis was significantly worse in diabetic women and younger patients.[4]

A definitive risk reduction has been shown in randomized control trials of treatment of people with prediabetes.[34] For diabetic patients, the treatment effects are difficult to separate from those of frequently associated comorbidities, such as hypertension. Nonetheless, there is no doubt that controlling both risk factors leads to decreased risk, and should thus be a therapeutic goal.[4]

1.3.5 Arrhythmias

Atrial fibrillation (AF) has long been established as a risk factor for cardioembolic stroke, with a fivefold increase in risk and increased attributed burden with age.[4] AF is discovered in up to 23% of cryptogenic stroke patients with a 3 to 4 week follow up, since AF is often asymptomatic.[4]

Several factors increase the risk of stroke in patients with AF. These include age, hypertension, DM, previous stroke or TIA, vascular disease, and female sex.[35,36]

1.3.6 Lipids

There is no clear association between different lipid subtypes at this point. In the future, randomized trials will be necessary to determine the association of cholesterol, triglycerides, and other sub fractions with specific stroke subtypes, and the treatment effect for targeted drugs.[37,38,39,40,41]

1.3.7 Smoking

Smoking is, together with high blood pressure, the strongest modifiable factor both in primary and

secondary stroke prevention. Strong countrywide tobacco control policies being instituted in the previous years in several different countries will hopefully lead to a decrease in stroke in the future.

Smokers have a two- to fourfold increase in stroke risk, compared to nonsmokers. Quitting after 10 years has been shown to reduce this risk significantly.[42,43] Heavy smoking has also been associated with increased risk.[43,44] Furthermore, a marked decrease in risk has been shown several years after quitting, with light smokers having the same risk as nonsmokers after a period of 5 years in some studies.[4]

Smoking might also synergize with other risk factors, such as hypertension.[45] This is likely related to both the direct effect of smoking on the body and the lifestyle of heavy smokers.

Second hand smoke has also been shown to be a dose-dependent risk factor for stroke, albeit the risk seems to be lower than active smoking.[46,47,48]

1.3.8 Exercise

Several studies have shown a clear benefit related to regular physical activity. The estimated reduction in stroke risk is up to 50% in some studies.[49,50,51] The benefit seems to be dose- dependent, with at least moderate to vigorous activity required for a clear benefit, although modest exercise might also be beneficial.[50,52,53,54] Most of the benefits attributed to exercise can probably be explained by the positive effect it has on other risk factors, such as hypertension and obesity.

1.3.9 Nutrition

One study has shown a clear benefit related to adhering to a calorie-unrestricted Mediterranean-style diet, with increased content of nuts and olive oil, fruits and cereals, and a reduced consumption of dairy products, meats and sweets.[55] Although this was a randomized trial, participants were middle-aged or elderly Spanish people with at least 3 risk factors for cardiovascular disease or diabetes, and there are several limitations that have been recognized by the authors.[55] Thus, strictly speaking, this intervention was effective in this population, and the benefits for adoption of this diet in younger patients, those without risk factors, or those with other comorbidities is unclear. It is very likely that a Mediterranean style diet in those populations will have a benefit, albeit small. Further studies are required to prove this.

Another recent study from a Danish cohort has shown some benefit to adhering to a Nordic diet, with increased consumption of fish, fruits, root vegetables and oatmeal.[56] Thus, both diets may be viable options for prevention of stroke. More important than these diets might be what they have in common, with reduced consumption of red meats, bread and flour derivatives, and sweets; these items could be possible targets of health policy. Future studies might be necessary to address whether the relevant elements of these dietary modifications are the elements whose consumption is increased, or those avoided.

Finally, specific dietary supplements might be relevant for stroke prevention in some populations. For example, in a study involving Chinese adults with hypertension, the addition of a folate supplement decreased stroke risk.[57] Although the effect of folates may not be significant in countries where food is enriched with it, it may be a reasonable intervention in those countries not adhering to this norm.

1.3.10 Chronic Kidney Disease

It has been consistently shown that low glomerular filtration rate is associated with increased stroke incidence, severity, morbidity and mortality. Moreover, this effect seems to increase the worse the filtration rate is.[58,59,60,61]

1.3.11 Oral Estrogen Therapy

Data from randomized clinical trials suggest that estrogen replacement therapy, whether alone or associated with progestin, increases stroke risk in postmenopausal women.[62,63,64,65]

When used as an oral contraceptive, estrogen increases stroke risk in women. This increase seems dose-dependent.[66,67,68,69] The association of migraine with auras or smoking also increases this risk significantly. The presence of all three factors confers nine times the risk, and should be avoided whenever possible.[70,71]

1.3.12 Sleep Apnea

In recent years, this frequent pathology in middle-aged people[72,73] has been associated with increased stroke risk, and represents a potential intervention to minimize stroke while improving quality of life. Studies suggest that the increase in risk depends on the severity of the apnea and affects males more than females.[74,75,76] It has also

been linked with an increase in morbidity after stroke[77] and mortality.[78,79,80]

In addition, obstructive sleep apnea has an extremely high prevalence in stroke survivors, of over 50%.[74,81,82] This is a very significant finding, since treatment might be a relevant factor in secondary stroke prevention for these patients.

At this point, further research is needed to determine whether current sleep apnea therapy is effective as primary or secondary stroke prevention with strong evidence levels.

1.3.13 Perinatal and Childhood Strokes

Even though its usually regarded as an infrequent occurrence, cerebrovascular disease is among the top 10 causes of death in the pediatric population.[83] Mortality is highest in the first year of life, with 7.8 deaths/100000, with an increased risk in males and those of African ancestry.[83]

Pediatric strokes are classified as perinatal when they occur between 28 weeks of gestation and 28 days of life, and as childhood strokes if they occur on older children.[83] The incidence of neonatal stroke is roughly 1 in 4000 live births per year,[83] and is a significant cause of morbidity and mortality.

The incidence of childhood stroke, increases with age, from 2–3 cases/100000 person-year for those under 5 years of age to 8 cases/100000 person-year for those under 14 years of age.[84] The relationship between ischemic and hemorrhagic stroke during childhood is approximately 1:1, unlike in adults.[85,86,87]

Known independent risk factors for perinatal stroke include infertility, preeclampsia, prolonged rupture of membranes, and chorioamnionitis,[4] and common associations are acute systemic disease (infectious and noninfectious), and prothrombotic states.[84]

In older children, the most common risk factor is arteriopathy, found in 50% of all cases, followed by congenital or acquired cardiopathy (24%), and prothrombotic states and hematologic diseases (20%-50%).[88,89] Congenital cardiopathy increases stroke risk by 19-fold.[90] Migraine also seems to be a risk factor for stroke in teenagers. In one US study, adolescents with migraines had a three times higher risk of stroke, but not younger children.[91] A 2005 metanalysis in adults and young adults has shown that it may be a significant independent risk factor for stroke, with approximately a two-fold increase in risk, which goes up to 8 fold in the presence of oral contraceptives.[92] Even though this study did not investigate a pediatric population, it raises powerful concerns, given that adolescents are starting earlier with hormonal contraceptives, which could lead to an increase in pediatric stroke if appropriate measures are not taken.

Trauma to the head or neck is also a risk factor for ischemic stroke, present in 10% of pediatric ischemic stroke patients.[93] Even though this is the reported percentage, in daily practice in our center traumatic arterial dissections in pediatric patients seem to be much higher. A possible explanation may be the underestimation of this pathology due to sub-utilization of endovascular diagnostic techniques.

In addition, recent infection (in the previous days) seems to increase stroke risk.[93,94] Finally, herpesvirus infection has been strongly linked to ischemic stroke in a study with 326 patients.[95] It must be noted that most infections were sub-clinical in this study.

Recurrence rates in pediatric stroke have been estimated at 10% at 5 years, and may be even as high as 25%.[96,97] Secondary prevention and strict follow-up is mandatory to prevent and control this.

1.4 Conclusion

Overall, rather than looking at each risk factor as a single element to correct, we believe that effective stroke prevention requires a lifestyle change, which is a long-term investment. This change requires both encouragement at the personal level by primary care physicians as well as public health policies that make it easier for people to exercise, reduce smoking and eat healthier diets. Moreover, improving outcomes requires better and faster access to healthcare, appropriate treatment, rehabilitation and secondary prevention. We are convinced this should be a worldwide effort of the medical community, since this is a true pandemic running unchecked.

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