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INVESTIGACIÓN ORIGINAL

PRESTACIÓN DE ATENCIÓN MÉDICA, FACTORES DE RIESGO CARDIOVASCULAR Y HEMORRAGIA INTRACEREBRAL ESPONTÁNEA EN LA POBLACIÓN COSTARRICENSE

DELIVERY OF HEALTHCARE, CARDIOVASCULAR RISK FACTORS, AND SPONTANEOUS INTRACEREBRAL HEMORRHAGE IN COSTA RICAN POPULATION

Rosales Bravo, Luis
Department of Anatomy and Clinical Department Hospital México, School of Medicine, University of Costa Rica, San Pedro de Montes de Oca, San José, Costa Rica. ORCID ID: https://orcid.org/ 0000-0002-0259-0476. Correo: luis.rosalesbravo@ucr.ac.cr

RESUMEN: Costa Rica es un país pequeño con una economía emergente con un gobierno democrático que no tiene ejército. Su sistema de salud es uno de los más eficientes del mundo y es el país latinoamericano con mayor esperanza de vida. Sin embargo, los factores de riesgo cardiovascular afectan cada vez más a esta población. El objetivo de este estudio fue revisar la prestación de atención médica, así como los principales factores de riesgo cardiovascular en la población costarricense y su relación con la hemorragia cerebral espontánea. Estos factores de riesgo se relacionan con el desarrollo de hemorragia intracerebral espontánea y, además, cabe mencionar que hay poca información científica en este país que relacione estas dos condiciones. De esta manera, se realizó una búsqueda actualizada en la base de datos PubMed (MeSH y DeCS) y se seleccionaron 79 artículos científicos. Se buscaron referencias adicionales en la base de datos del autor. Se concluye que la población costarricense posee una mayor exposición y vulnerabilidad a la hemorragia intracerebral espontánea, esto debido a la alta prevalencia de factores de riesgo cardiovascular en este grupo y a una mayor esperanza de vida.

Palabras clave: prestación de atención médica, hipertensión, fumado, obesidad, hemorragia cerebral. **Fuente**: DeCS, BIREME.

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ABSTRACT: Costa Rica is a small country with an emerging economy and a democratic government, that does not have an army. Its healthcare system is one of the most efficient systems around the world. It is the Latin American country with the highest life expectancy. Nevertheless, cardiovascular risk factors increasingly affect this population. The goal of this study is to review the delivery of healthcare and the main cardiovascular risk factors in the Costa Rican population and its relationship with spontaneous intracerebral hemorrhage. These risk factors are related to the development of spontaneous intracerebral hemorrhage. There is little scientific information -in this country- that relates to these two conditions. Therefore, an updated research was carried out in the PubMed database (MeSH and DeCS) 79 articles were selected. We also searched for additional references in the author's database. Regarding conclusions, Costa Rican population has increased vulnerability to develop spontaneous intracerebral hemorrhage due to the high prevalence of cardiovascular risk factors and because of the-longer life expectancy.

Key words: delivery of health care, hypertension, smoking, obesity, cerebral hemorrhage. **Source**: DeCS, BIREME.

INTRODUCTION

Located in Central America, Costa Rica is a small country with 51.100 km^2 **(1, 2)**, divided into seven small departments (provinces). It has no army and has a democratic government system. Costa Rica has one of the most efficient health systems globally and has the highest life expectancy in Latin America **(3)**. One of the 5 *Blue Zones*, Península de Nicoya, is located in Costa Rica (shown in Figure No. 1).

Figure No. 1. Geographic location of Costa Rica in the World map. Costa Rica is located in Central America. The dark area shows the Blue Zone, Península de Nicoya.

In these zones, the people consistently live for more than 100 years. Besides, the whole population is aging at a rapid pace. It is expected that the number of people with age of 60 years old and over will double from year 2000 to 2025.

The lifestyles of Costa Ricans have changed in the last years, especially feeding habits. Many cardiovascular risk factors make this population vulnerable to develop cerebrovascular disease (CVD). This is particularly true for spontaneous intracerebral hemorrhage (ICH). Few clinical and demographic data is available about CVD. This review's primary goal is to analyze the cardiovascular risk factors that affect the Costa Rican population and to link these cardiovascular risk factors with the potential risk of ICH. Finally, it has been done concise review of the actual knowledge regarding ICH.

PUBLIC HEALTH SYSTEM

According to the United Nations Population Fund, Costa Rica has about 5.1 million citizens **(4)**. It is considered a developing country with an emerging economy. Since 1941 it has a very efficient social healthcare system. In 1961 the legal arrangements were established so that the healthcare system was universal and solidary **(5)**. This system covers 85.6 %-87.6 % of the population (citizens and immigrants)**(6)**. The government finances it by about 75 % **(7)**. The state invests approximately 9.3 % of the Gross Domestic Product (GDP) on public healthcare **(8)**.

Because of these reasons, the leading health indicators (life expectancy, birth rate, fertility rate, and maternal mortality) are similar to that of developed countries (shown in Table 1). Special mention deserves the infant mortality rates, one of the lowest globally **(2, 8)**.

Table No. 1. Demographics and health indicators of Costa Rica

Indicator	Value
Area (sq. km)	51 100
Population (million citizens)	5.1
Life expectancy at birth (years)	80
Fertility Rate per women	1.7
Maternal mortality ratio (deaths per 100 000 live births)	27
Children under-five mortality rate (number of deaths per 1000 live births)	8.8
Total expenditure on health as % of GDP	9.3

In 2004, Costa Rica had a vast network of public healthcare centers (692), including primary health care centers (EBAIS for its abbreviation in Spanish), clinics, and hospitals **(9)**. By 2006 the government increased the number of EBAIS to 893 **(10)**. By 2011, the country had 947 EBAIS, 11 major clinics, 13 peripheral hospitals, 7 regional hospitals, 3 third-level hospitals and 4 specialized hospitals **(6)**.

Half of the Costa Rican population lives less than 1 km from an EBAIS and 5 km from a major clinic or a hospital **(9)**. In this way, the government guarantees adequate accessibility to healthcare services. According to that, hypertensive and diabetic patients are treated in an EBAIS every four months and three months, respectively **(11)**.

PRIVATE HEALTH SYSTEM

Similarly, Costa Rica has an extensive private healthcare system. This system is expanding every year, increasing the coverage of healthcare for the population. There are 9 private hospitals in the national territory **(12)**. Also, there are 468 private clinics and consulting rooms **(13)**. As claimed by the Health Expenditure Survey carried out in 2006, the Costa Rican population has a high preference for visiting a private healthcare service **(14)**. About 56 % of the population attended a private healthcare facility, as stated in a survey carried out by the University of Costa Rica in 2006 **(15)**. Nearly 50 % of the population would prefer to stop contributing to the social healthcare and join a private healthcare system. The main reason is the long waiting time until an attending physician sees the patients in the public healthcare system, according to a report issued by a Government Agency in 2009 **(16)**.

COSTA RICAN CARDIOVASCULAR RISK FACTORS

The prevalence of chronic diseases related to increased cardiovascular risk is very similar to developed countries, especially compared to the United States **(17)**. Additionally, there has been a change in the lifestyle of the communities. This change has favored an increase in the prevalence and incidence of cardiovascular and cerebrovascular disease.

Related to chronic hypertension (HT), one of four adults is a hypertense patient, a proportion that increased by 10 % in the last 15 years **(18)**. The estimated overall prevalence of HT is 25.6 % **(19)**; in 65 years old and over, it rises to 61 % **(10)**. HT is the second leading cause of seeking medical care in outpatient services in public healthcare centers

(10). The mortality rate from high blood pressure has tended to double in recent years **(20)**.
Regarding Diabetes Mellitus (DM), its overall prevalence ranges from 6.4 % - 13 % **(19, 21-23).** It has an incidence of 1.62 cases per 100.000 inhabitants per year **(23).** The overall prevalence of patients with high fasting blood glucose is about 16.5 % **(22).** Furthermore, it has been determined that high amounts of the lipid cis-9, trans-11 isomer of linoleic acid in the adipose tissue were associated with a lower prevalence of diabetes. Adipose tissue amounts of these isomers were significantly lower in adults with diabetes than in adults without diabetes in Costa Rican population **(21)**.

The prevalence of overweight and obesity ranged from 59.7 % -77.3 % in the population between 20-64 years of age **(24)**. The urban population has a higher prevalence of systemic obesity and abdominal obesity than the rural population, especially men **(25)**. Both types of obesity are independently associated with the development of diabetes, increased risk of CVD, and coronary artery disease. It is well demonstrated that obesity causes peripheral resistance to insulin, leading to hyperglycemia. Insulin resistance causes an increase in the synthesis of apolipoprotein C-III (Apo C-III). The ApoC-III leads to an alteration in the plasma clearance of apo B lipoproteins, which increases the concentration of triacylglycerol **(26)**. The increase in both lipoproteins (Apo C-III, Apo B) is related to a high risk of cardiovascular disease in Costa Rica since it accelerates and activates the systemic arteriosclerotic process **(26)**.

Despite that the consumption of trans fatty acids in the Costa Ricans diet has decreased in recent years, it remains high **(27)**. Trans-fatty acids are found mainly in soybean oil and palm oil, which are used in food preparation. Excess consumption of trans fatty acids is related to an increased risk of acute myocardial infarction **(27)**. Replacing palm and soybean oils with vegetable oils containing polyunsaturated non-hydrogenated fatty acids (linoleic acid and α-linoleic acid) could reduce atherosclerosis and cardiovascular risk in the country, particularly the risk for heart attack **(28)**. These polyunsaturated fatty acids reduce LDL-cholesterol levels, increase peripheral insulin sensitivity, inhibit platelet aggregation, reduce systemic blood pressure, and decrease cardiac arrhythmias **(28)**.

The establishment of fast-food restaurants has varied the eating habits of consumers. The high salt content in many foods of these restaurants has been well demonstrated **(29)**. High salt intake is related to the development of HT and cardiovascular disease.

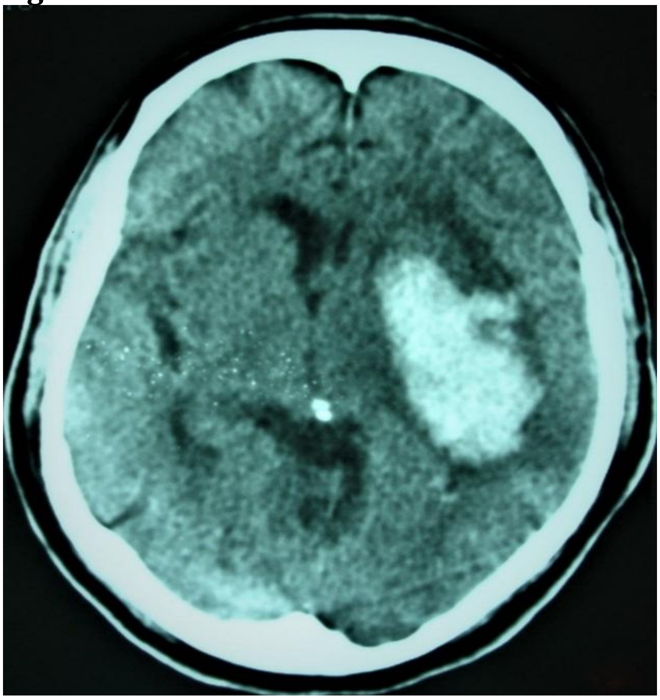
On the other hand, it exists a direct relationship between smoking and the development of ischemic CVD—nearly half a million Costa Ricans (13.5 % of the total population) smoke **(30)**. The smoking habit begins very early , about the age of 10 years old **(31)**. Although, the prevalence of smoking among teenagers between 13-15 years old has significantly decreased because the public health policies, the proportion of young people addicted to smoking has increased **(32)**. It will be more frequent in this context that the Costa Rican population suffer from CVD since several cardiovascular risk factors are exposed.

Approximately 57.1 % of the adult population reported having had at least one alcoholic drink in the last 12 months (median incidence). Men report a greater incidence (67.8 %) than women (46.4 %) **(33)**. The median age at which regular alcohol consumption starts is 18 years old in the general population **(33)**. While a light-to-moderate alcohol consumption (1-2 drinks/day) decreases the risk for ischemic stroke, it does not affect hemorrhagic stroke risk. Heavy alcohol consumption (>4 drinks/day) is associated with a statistically significant (CI 95%, p <0.05) increase in the risk of all types of stroke: Ischemic stroke (RR 1.14), intracerebral hemorrhage (RR 1.67), and subarachnoid hemorrhage (RR 1.82). The most noticeable effect in risk increase being in hemorrhagic stroke **(34)**. The most significant risk for alcohol abuse among the Costa Rican population is for men, ages 25-34 years old, who live in the Great Metropolitan Area. According to the Public Ministry of Health, 28 % of the people who regularly consume alcohol report heavy alcohol consumption **(33)**.

SPONTANEOUS INTRACEREBRAL HEMORRHAGE

ICH represents around 20 % of CVD. Spontaneous ICH refers to a non-traumatic brain bleeding caused by a ruptured cerebral artery or vein. This hemorrhage can be located in three different anatomical sites: intracerebral (intraparenchymal), intraventricular, or both. The most frequent is the parenchymal hemorrhage (shown in Figure No. 2).

Figure No. 2. Non-contrast axial brain-CT



This figure shows hyperdense lesion (bleeding) located at the level of the left putamen. Also, some degree of compression of the anterior and posterior horn of the left lateral ventricle are observed. There are some shift of the middle line to the contraleral side.

About 60 % of ICH are secondary to HT (sudden increase in blood pressure), 20 % to amyloid angiopathy and the remaining 20 % are secondary to various causes as oral anticoagulants (OA), brain tumors, use of anticoagulants, vascular malformations (dural fistulas, arteriovenous malformations), and rupture of brain aneurysms.

ICH is one of the most devastating CVD subtypes. It is associated with high mortality, close to 40 % during the first 30 days **(35)**. A high proportion of patients die in the first two days. Only between 12 % -39 % of patients achieve long-term functional independence **(36)**.

The early death rate is higher in older adults, females with history of HT, and OA **(37)**. Contrary, the factors associated with a lower mortality rate are hypothyroidism and obesity **(38)**. Those patients that survive usually persist with severe neurological deficits.

Frequently many of these patients are readmitted to the hospital because of various medical and surgical complications, which include: sodium concentration disturbance, venous thromboembolism, lung infections, gastrostomy dysfunction, external ventriculostomy and history of craniotomy **(39)**.

The glycemic level also influences the clinical prognosis in this group of patients, particularly in the post-event stage. Hyperglycemia is a response to acute stress caused by cerebral hemorrhage. It has been associated with increased hematoma volume, more significant neurological damage, and worse clinical evolution **(40)**. Transient hyperglycemia can cause brain damage through complex neuro-inflammatory mechanisms (cytokines, oxidative stress, and calcium metabolism) **(41, 42)**.

RISK FACTORS IN ICH

The main risk factor related to ICH is HT. Sustained hypertension causes degenerative changes in the wall of the small cerebral arteries. These changes consist mainly of fibrinoid necrosis of the sub-endothelium with the formation of microaneurysms and focal ectasias, which weaken the arterial wall **(36)**. Such arterial microaneurysms are known as Charcot-Bouchard.

The normal circadian rhythm causes a 10-20 % reduction in blood pressure during sleep and constitutes a cardiovascular system's protective mechanism. In hypertensive patients, this mechanism is lost, and contrary, they present a nocturnal increase in blood pressure. These can result in endothelial dysfunction, remodeling of the small cerebral arteries, and affect hypertensive patients **(43).**

The second most important risk factor is cerebral amyloid angiopathy (CAA) **(44).** It is the deposition of β-amyloid in capillaries, arterioles, and small and arteries in the cerebral cortex, leptomeninges, and cerebellum **(45)**. Typically, β-amyloid is involved in the reduction of cellular oxidative stress and the regulation of cholesterol transport **(46)**. This macro protein excessive deposition in the arterial walls leads to the small cerebral perforating arteries rupture **(47)**.

Apolipoprotein E (ApoE) contributes to the cellular behavior of β-amyloid, which is also an essential component of arterial atheroma plaques. The polymorphism of the gene that encodes for Apo E synthesis is linked to an increased ICH risk. The ApoE gene is located on chromosome 19 and encodes a lipoprotein composed of 299 amino acids. A recent meta-analysis reported that the ε4 and ε2 alleles' polymorphism are risk factors for ICH, mainly in white patients **(48)**.

Diabetic patients have a 3-4 times higher risk of having ICH compared to non-diabetics. DM induces angiopathy (thickening of the basement membrane of the small cerebral arteries and proliferation of the endothelium) **(41)**. DM is a risk factor for atherosclerosis, which harms the microvasculature. The former causes a condition known as diabetic microangiopathy **(41**, **42).** This explains why diabetic patients are more likely to suffer ICH.

The use of oral anticoagulants (OA) is another risk factor related to ICH. OA can be of two types: antiplatelet agents (aspirin, clopidogrel, dipyridamole, ticagrelor) and anticoagulants (warfarin, rivaroxaban, dabigatran, apixaban). These medications can be prescribed as monotherapy (aspirin only) or in combinations (warfarin plus aspirin). They are mainly used as a treatment for the primary and secondary prevention of thrombotic events. Recently, was demonstrated that the combined use of warfarin + aspirin + clopidogrel was associated with an increased risk of having ICH **(49).** Those patients who had ICH due to the use of warfarin had higher 90 days' mortality. The OA associated with a lower risk of ICH was dabigatran **(49)**.

Age is a non-modifiable risk factor. This disease is more prevalent in people older than 65 years. However, the population group younger than 50 years (range 18-50) could be affected. HT is also the leading risk factor in this age group **(50)**.

Air pollution is linked to an increased likelihood of ICH. Microparticles levels on air bigger than 77.45 $\mu g/m^3$ correlate with a greater probability of having ICH, especially in those over 65 years of age and diabetics **(51)**. Exposure to these toxic microparticles in the air in experimentally observed humans and animals allowed for the documentation of hemostatic alterations, systemic inflammation, damage to the capillary endothelium and vascular dysfunction **(51)**.

High alcohol consumption is a risk factor for ICH. High consumption is considered 40> g/d or> 300 g/week. Patients with high alcohol consumption who have ICH compared to non-alcoholics are 11 years younger, have a smoking habit, have a worse prognosis and the bleeding' location is mainly in the posterior fossa **(52)**. Patients with alcoholic cirrhosis, mainly men aged between 20-49 years, have a high risk of ICH **(53)**. The development of cirrhosis in this group of patients causes significant disorders in blood coagulation (hemorrhagic diathesis), alters the autoregulation of cerebral blood flow, and promotes HT's development **(53)**.

Although smoking increases the risk of ischemic stroke and subarachnoid hemorrhage, it is not identified as a risk factor for ICH **(54).** Its effect on the functional outcome of patients with spontaneous ICH is on debate. Preclinical ICH models associate the stimulation of the a7-nicotinic acetylcholine receptor (a7-nAChR) and its anti-inflammatory effect with improved neurological outcomes **(55).** However, recent clinical studies have shown no significant difference in functional outcome at 90 days between non-smokers and current smokers. The same was found between recent smokers (30 or fewer days) and non-recent smokers, measured by the modified Rankin Scale (mRS) and Barthel Index **(55)**. Other study found no difference in the long term functional outcome (mRS at 12 months) among spontaneous ICH patients with only nicotine use and patients without legal drug use (alcohol and or nicotine) **(56)**. Furthermore, smoking is associated with an earlier age of ICH presentation and increased ICH-related mortality in former or current smokers compared to non-smokers **(55)**. This suggests that the harmful effects of smoking on the overall health outcomes outweigh the probable neuroprotective effects of nicotine **(55)**. Low serum LDL-Cholesterol levels <70 mg/dl and triglycerides <74 mg/dl have been linked to an increased risk of ICH **(57, 58).** This increased risk is related to necrosis and weakening of the arterial wall's middle tunic, which alters the endothelium, making it more susceptible to microaneurysms **(58)**.

NEUROIMAGING

The study of choice to evaluate extension, location, and volume of ICH is a non-contrast brain CT. It is a quick study to perform with high sensitivity to diagnose patients in which intracranial hemorrhage is considered **(47, 59)**. An intracerebral hematoma (IH) volume of ≤ 30 ml is considered a small extent, and one of ≥30 ml is regarded as a great extension. The latter is related to higher morbidity and mortality **(60)**.

The growth of IH is very common. It can be observed within the first 24 hours after symptom onset but predominantly occurs in the early hours **(61)**. Approximately 15-23 % of patients present hematoma expansion in the first several hours **(47)**. Hematoma growth causes the patient's neurological deterioration, poor outcome, and death **(62)**. IH expansion occurs in about 70 % of ICH patients and is more likely to happen in those cases with an initial hematoma volume ≥30 ml **(61)**.

The measure of the IH volume is very important both to take urgent treatment decisions (surgical evacuation) and to define the clinical prognosis **(47, 63)**. To date, the most common way to calculate this volume is by using the ABC/2 method (measures of the maximum diameter (in mm) of the hematoma in the perpendicular, axial and coronal planes are multiplied by each other and then divided by 2 **(47)**. Although, it is a quick method and provides an approximate idea of the hematoma volume, it is highly dependent on who reports the CT-scan. A recent study compared the ABC/2 method, sABC/2 (a simplified version) with the planimetric form. It suggested that while both are accurate instruments to calculate the volume of the hematoma (demonstrated by concordance with the planimetric method), sABC/2 showed less bias and may be more sensitive in differentiating a volume threshold of 30mL **(63)**.

With the new CT-scan software named Convolutional Neuronal Network (CNN), 3D quantification and automatic segmentation techniques to measure the IH could be done. This technique gives a more accurate volume of IH **(64)**.

To predict by the initial brain CT-scan which one is more likely to have a hematoma growing (an increase of more than 33 % in size or > 6 ml in volume), various protocols and scales have been designed. One of these scales assigns a maximum score of 10 based exclusively on the initial brain CT-scan. This scale is mainly based on IH's initial volume and its tomographic morphological characteristics **(65)**. The presence of the "spot sign" in the initial angio brain-CT is closely correlated with an increase and expansion of IH **(66)**. Both diagnostic methods can contribute to the early identification and treatment of this group of patients.

Another predictor of IH expansion is the differential count of white blood cells. A marked inflammatory process occurs quickly when the when the ICH begins. This causes the migration of leukocytes around the lesion due to the disruption of the blood-brain barrier (BBB). There is an imbalance between procoagulant substances (stabilize the hematoma) and anticoagulant substances (favor hematoma expansion) in the bleeding site. In a recent study, it was observed that the increase in the eosinophil count (45 cells / μL) in the incoming leukogram is directly associated with the IH growing, particularly if it has a volume> 30 ml **(35).** It is not yet clear how eosinophil activity contributes to this phenomenon.

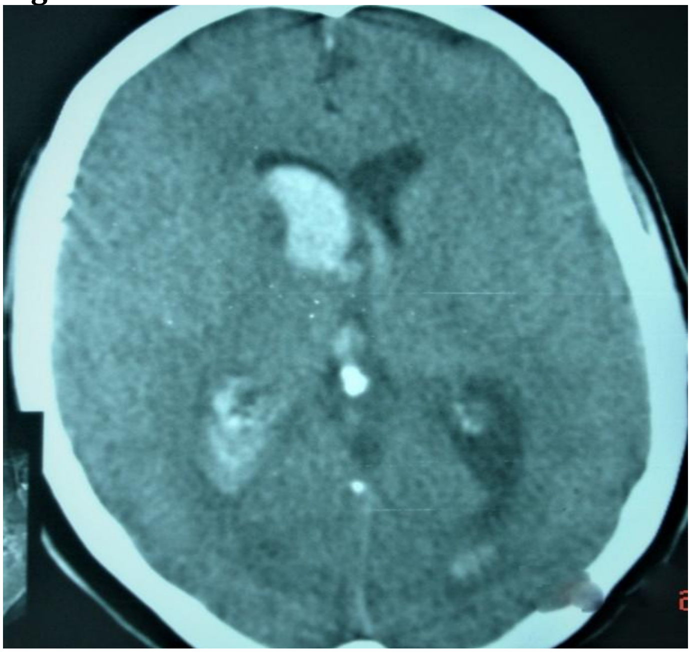
The extension of the IH to the ventricular system occurs often. Hypertensive bleeding (located in the basal nuclei and thalamus) frequently drains into the third ventricle or the lateral ventricles. The bleed may cause a slowing or obstruction of the cerebrospinal fluid (CSF) circulation leading to obstructive hydrocephalus. These may lead to an increase of intracranial pressure with a worsening of the patient's neurological state. Bleeding at the level of the head of the caudate nucleus causes extension of bleeding into the lateral ventricles, too (shown in Figure No. 3) **(67)**.

MEDICAL MANAGEMENT

General measures of ICH management include basic ABC: securing the airway (endotracheal intubation if necessary), ensuring oxygenation, and maintaining adequate blood pressure. Also, glycemic levels should be kept below 140 mg/dl, avoid hyperthermia, and keep sufficient blood volume using isotonic solutions. It is also essential to prevent deep vein thrombosis of the lower limbs with antithrombotic prophylaxis. Additionally, it is vital to guarantee adequate parenteral nutrition because of the high energy expenditure of this kind of patient **(68).**

More than 70% of patients with ICH are admitted with systolic blood pressure (SBP) higher than > 140 mmHg. The increase in SBP is related to IH growing during the first 24 hours. The intensive reduction of SBP to maintain it lower than <140 mmHg during the first hour of admission is safe for the patient. This reduces the possibility of IH growing without compromising cerebral perfusion in the perihematomal area **(69).**

Figure No. 3. Non-contrast axial brain-CT



Non-contrast axial brain-CT shows hyperdense lesion (bleeding) located at the level of the head of the right caudate nucleus causing extension of the bleeding mainly into the right lateral ventricles (anterior and posterior horns). Some degree of bleeding is also observed into the left lateral ventricles and the third ventricle.

Extravasation of blood into the brain parenchyma promotes the onset of an active inflammatory process. This causes a significant cytotoxic and vasogenic edema around the IH. This process leads to a disruption of the BBB. The disruption of the BBB generates the migration of more inflammatory cells. The inflammatory process can last up to 21 days. Microglia, astrocytes, and T lymphocytes are the primary cells involved in the perilesional edema **(70)**.

Experimentally in animal models, some drugs have been studied to reduce the neuroinflammatory process related to ICH. Hypoglycemic agents of the thiazolidinedione group (Rosiglitazone) could reduce the pro-inflammatory factors produced by microglia. Tetracyclines (minocycline) could reduce the concentrations of metalloproteinases and TNF-α. Finally, fingolimod a sphingosine-1 receptor modulator that prevents the migration of active T lymphocytes to the central nervous system has been also tested **(71)**.

Statins (atorvastatin, simvastatin) are drugs used in both acute and post-ICH management. Such drugs have been shown to have various neuroprotective effects in both animal and human experimental studies. These effects include improving neurological function, reducing cerebral edema, an increase of angiogenesis and neurogenesis, reabsorption of the hematoma, and reducing inflammatory cells **(72)**.

Special mention deserves those cases of ICH secondary to oral anticoagulants. In the case of warfarin, reverse anticoagulation with vitamin K 10 mg IV and prothrombin complex concentrate (30 IU / kg) during the first 4 hours. The goal is to bring the INR lower than <1.2. **(75)**. For thrombin inhibitors (dabigatran), their effect should be reversed with the monoclonal antibody idarucizumab (Praxbind®) at a single dose of 5 grams IV. For factor Xa inhibitors, modified recombinant factor Xa (andexanet alfa) should be administered IV **(73)**.

The controversy arises in those cases in which patients with ICH need to be anticoagulated because of a particular medical condition (e.g., mitral or aortic valve replacement, AF). Special conditions which could increase the risk to present cerebral or peripheral thromboembolic complications. The doubt arises if by normalizing the INR and starting IV anticoagulation with heparin sodium, there will be a significant risk of rebleeding ending up with IH growing. Current evidence supports IV heparin treatment (TPT prolongation 1.5-2 times) after INR normalization in patients with ICH requiring urgent anticoagulation. Depending on the patient's neurological condition and functional prognosis, it may be considered to restart OA two weeks after ICH **(74)**.

Due to immobilization caused by neurological deficits (hemiparesis), the DVT risk could be as high as 70 %. The lower limb's immobility causes slowing of the venous return and a hypercoagulable state in this vascular territory. DVT is the leading risk factor for developing PTE. DVT is a severe complication that increases morbidity and mortality. Therefore, preventing DVT is an essential part of medical treatment. Prophylactic doses of fractionated heparin (sodium heparin) or LMWH (enoxaparin) can be started since the second day of admission with this purpose. This neither increases the risk of brain rebleeding nor neurological deterioration **(75).**

Finally, patients who need a platelet antiaggregant (aspirin) to prevent cardiovascular events use aspirin two weeks after ICH is safe. This neither increases the risk of mortality nor disability **(76)**.

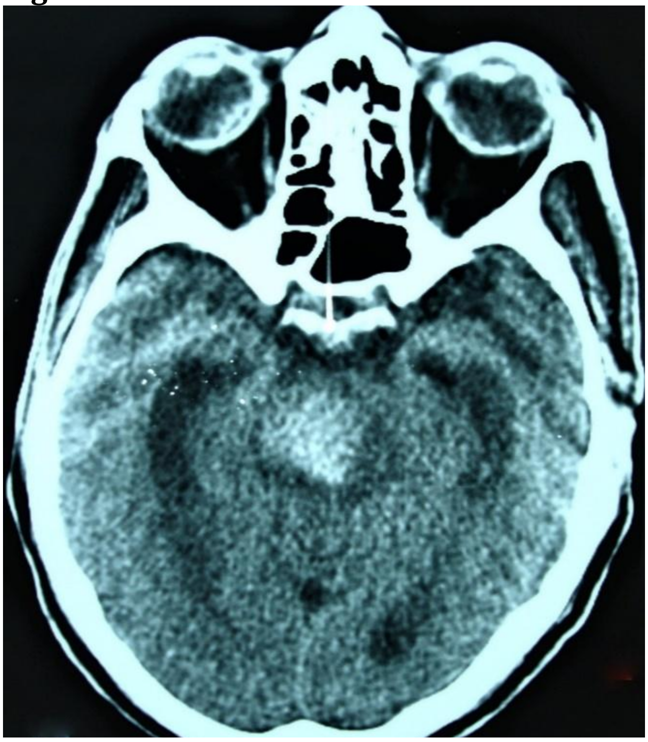
SURGICAL TREATMENT

Most patients with ICH do not require brain surgery. Sometimes the anatomical location and volume of the IH could be a life-threatening condition. The mechanisms that can lead to this are mass effect, herniation of intracranial structures, sudden increase of intracranial pressure, and abrupt blockage of CSF (shown in Fig. 4) excitotoxic/neurotoxic effect of blood degradation products.

Theoretically, there is a benefit of surgical drainage of the IH. Among the surgical modalities available are open craniotomy, decompressive craniectomy, neuroendoscopy, minimally invasive catheter-guided hematoma evacuation, external ventriculostomy, and placement of a ventricular-peritoneal shunt **(77)**.

Despite these surgical procedures and after many clinical studies in this regard, to date, the benefit of surgical evacuation of the IH has not been well established when compared with the best medical treatment. An exception are patients who have a hemorrhage in the posterior fossa with acute hydrocephalus, compression of the brain stem, and a decline in their neurological condition. In such cases, surgical intervention can save their lives but does not necessarily reduce overall patient mortality. But suppose the medical center where these procedures are performed (particularly open craniotomy) does many of these surgeries per year. In that case, this may favor the clinical prognosis, given that the learning curve has been increased **(78)**.

Figure No. 4. Non-contrast axial brain-CT



Non-contrast axial brain-CT shows hyperdense lesion (bleeding) located at the level of the pons compressing the Silvio aqueduct. These compression causes blockage of the CSF leading to acute hydrocephalus. Both posterior horns of the lateral ventricles are enlarged.

CONCLUSION

This review has described the relationship between the delivery of healthcare, cardiovascular risk factors, and ICH in the Costa Rican population. Despite being a small country, Costa Rica has one of the most efficient healthcare systems worldwide. It has an extensive network of both public and private care services. This allows having excellent leading health indicators, particularly a long-life expectancy and low infant mortality rates. Therefore, the proportion of patients older than 60 years tends to increase gradually.

The prevalence of chronic diseases related to cardiovascular risk, greater life expectancy, eating habits, and Costa Rican population lifestyles make them increasingly prone to cardiovascular diseases, including ICH. Scarce information is available about the prevalence and incidence of ICH in this country. In a recent descriptive study, the prevalence of hemorrhagic CVD was 20.5 %, being HT, DM, and dyslipidemia, the three most common risk factors founded **(79)**.

Despite the above, Costa Rican population is similarly exposed to cardiovascular risk factors related to ICH development than the global level. Most of these factors have been studied in this population, such as HT, DM, overweight/ obesity, eating habits, smoking, and alcoholism. No scientific information could be found on OA's use, air pollution, and risk of ICH in the Costa Rican population. More studies are required about these topics. This review aimed to contribute to encourage the government to create policies to reduce and control cardiovascular risk factors related to ICH.

Finally, more local clinical studies in the field of ICH are needed to obtain information about incidence, prevalence, clinical course, mortality, complications and readmission rates.

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COMPETING INTERESTS

The author declare that no competing interests exist.

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CORRESPONDENCE

Rosales Bravo, Luis.
luis.rosalesbravo@ucr.ac.cr

