

Cannabis and the Cardiovascular system

(An extract from Cannabis: 'A General Survey of its Harmful Effects'
Mary Brett updated January 2017

Comparatively little research has been done in this area, but there are sufficient published scientific papers to raise concern.

At first the intoxication produced by cannabis causes an increase in heart rate of between 20 and 50% (Huber et al 1988, Jones 1984). A rise in blood pressure occurs if the person is sitting or lying, but on standing up the pressure drops, in some cases causing the person to faint (Maykut 1984). A new and naive smoker may be concerned about these effects (Sidney 2002), but someone with a healthy heart is not thought to be at risk.

Cannabis affects the cardiovascular system in other ways as well. THC increases the production of chemicals called catecholamines which stimulate the heart, it also has analgesic properties which may lessen any chest pain and delay the seeking of treatment and the level of carboxyhaemoglobin is raised, decreasing the supply of oxygen to the heart, placing it under greater strain (Jones 1982 and 1984).

Older field studies involving chronic cannabis users in Costa Rica (Carter et al 1980), Greece (Stefanis et al 1977) and Jamaica (Rubin and Comitas 1975), found no evidence of cardiac toxicity even in subjects with existing heart disease. And electrocardiographic studies in both acute and prolonged administration have rarely revealed pathological changes (Benowitz and Jones 1975, Jones 1984). So again it was concluded that young healthy adults using cannabis intermittently ran no major risk of a life-threatening cardiovascular event as may occur with a drug like cocaine. (Gawin, Ellinwood 1988).

However tolerance quickly develops to the acute cardiovascular effects of cannabis (Benowitz and Jones 1975, Jones and Benowitz 1976, Nowlan and Cohen 1977). And Jones (1984) showed that in people receiving daily high doses by mouth, tolerance develops in 7 to 10 days. This could possibly help to explain why toxic effects are sometimes not seen.

More recently though, there have been a number of papers documenting myocardial infarction and angina pectoris among young people using cannabis.

Podczeck and others 1990 reported 2 cases of myocardial infarction in very young healthy people and Choi and Perl 1989 and Perl and Choi 1992 found the same in young men, heavy users, with no history of heart disease. In 2000 Kosior and others wrote about 2 cases of cardiac arrhythmia (one of atrial fibrillation and one of recurrent paroxysmal tachycardia) in youngsters. Jones in 2002 reported transient ischaemic attacks and strokes in young and older people as well as deaths in young people from myocardial infarction.

Three teenagers, 15, 16 and 17, who "binge smoked" cannabis suffered strokes, two died and one was left paralysed. In the two who died the stroke appeared to have been triggered by a clot in the brain or a constriction of the blood vessels over a wide area (Geller et al 2004). Professor John Henry of Imperial College said it was very disturbing, "I have seen cases of stroke due to cannabis use but fortunately none of my patients have died. One woman had all the signs of a stroke with paralysis down one side but fortunately recovered after several days".

A 36 year-old man suffered strokes on three separate occasions, at almost yearly intervals, shortly after smoking a large amount of cannabis. He had been an occasional cannabis user, did not use other drugs and drank only occasionally. He had no known risk factors for stroke and no narrowing or hardening of the arteries which may lead to strokes or heart attacks. Mateo et al in 2005 said, "...even if the side effect is rare, it is a serious one"

An item in The Crawley News (Trinity Mirror PLC) on 12/07/06 reported that a 23-year-old sales manager had collapsed and died from a brain haemorrhage. He was a fit, healthy man with no hardening of the brain arteries but had a history of cannabis abuse and had been complaining of headaches for some time. At the inquest, Dr Colin Hunter-Craig said, "He died of a brain haemorrhage

due to cannabis abuse... This is incredibly rare in young people, but in old people we would recognise this as a stroke”.

Research in 2001 by Herning et al using Transcranial Doppler Sonography (Sound waves to measure cerebral artery blood flow resistance) found that prolonged marijuana use in 18 to 30 year olds increased the resistance in these arteries so restricting blood flow to the brain. 16 long-term male users were compared with 19 non-users. The deficit persisted for 4 weeks after abstinence. They compared the results to that of the brain of a 60 year old. Advancing age increases the chance of a stroke.

Mittleman and others in 2001 interviewed 3882 patients with heart attacks. He concluded that the risk of onset of myocardial infarction rose by almost 5 times in the hour following the smoking of a joint.

2002 Clinical Cardiology carried an article by McLeod L et al on myocardial infarction in a young man following the combined use of cannabis and viagra. Viagra is metabolised predominantly by cytochrome P450 3A4 isoenzyme. Cannabis is a known inhibitor of this isoenzyme. Caution is needed in prescribing viagra in cases where the person has cardiovascular disease because of the vasodilatory effects of viagra.

In January 2004 an article in Neurologist by Moussouttas reviewed all reported cases of presumed cannabis related cerebral ischemic events in the medical literature, as well as pertinent human and animal experimental studies on the cardiovascular and cerebrovascular effects of cannabis. His conclusion was “Cannabis use seems to have been causally related to several instances of cerebral ischaemia and infarction. Proposed etiologic mechanisms have included cerebral vasospasm, cardio-embolization and systematic hypotension with impaired cerebral auto-regulation, but most of the available data points to a vaso-spastic process. The exact relation to cerebro-vascular disease remains to be determined”.

We still do not know the long term effects of exposure to cannabis smoke on the cardiovascular system over several years but our experiences with the problems of tobacco smoke should make us very cautious. Jones (1984) suggested that, “after years of repeated exposure, there may be lasting, perhaps even permanent alterations of the cardiovascular system function”. He says, “ There are enough similarities between THC and nicotine’s cardiovascular effects to make the possibility plausible”.

One paper in 2004 involving a study on genetically modified mice found that THC helped prevent atherosclerosis, a “furring up” of the arteries caused by plaques of protein and other material. The study was headed by Francois Mach a cardiologist, and published in Nature. He warned that smoking cannabis would not be the answer as oxygen levels are reduced and THC increases the heart rate and interferes with blood pressure as previously described. He called for THC (already available as a medicine, Nabilone) or other cannabinoid derivatives to be investigated for this role. This is in line with all licensed medicines that must be pure single chemicals and subjected to standard clinical testing. This request was repeated in another paper by Mach and Steffens in January 2006.

In 2005 a letter to the editor of The International Journal of Cardiology was sent by Lindsay et al. It described 2 distinct cases giving cause for concern. In the first, “cannabis use precipitated a malignant arrhythmia in a patient with critical ischaemia from long-standing coronary artery disease. In the second, a young patient presented with an acute myocardial infarction that had started while smoking marijuana; subsequently diffuse coronary artery disease was found at angiography despite the patient’s low risk factor status”.

A case of paroxysmal atrial fibrillation (AF), a common condition usually triggered by alcohol use, was documented when a young female 22 year old presented herself. She had normal echocardiography but was a regular daily (1-2 joints) cannabis smoker. The author, Charbonney in 2005, warned that marijuana was an unusual trigger but should be checked for in young people after alcohol consumption had been ruled out.

The Irish Examiner on 3rd May 2007 reported the sudden death of a 21 year-old fit young father. Tiny traces of cannabis were found in his system. Assistant state pathologist, Dr Margaret Bolster said David Kelly died because the rhythmical electrical pulse in his heart misfired, causing it to stop. She pointed to a growing body of medical evidence which shows links between the triggering of similar heart

conditions and the use of drugs like cannabis and cocaine. The individual may have had an underlying genetic cardiac problem, this happens in almost a quarter of such cases.

A study in February 2008 on atrial fibrillation and marijuana smoking by Korantzopoulos et al links atrial fibrillation with marijuana smoking. Only healthy young male smokers took part and it was found that “Compelling evidence is accumulating that cannabis has significant haemodynamic (change in blood pressure) and electrophysiological (tachycardia and atrial fibrillation) effects on the cardiovascular system”. The authors concluded that atrial fibrillation should be included in the cardiovascular complications of marijuana smoking. Its incidence in the general population is probably underestimated.

A 2008 paper by Mukamal et al found that marijuana use was associated with a 3-fold greater mortality after acute myocardial infarction. This suggests there may be particular risks for people with established cardiovascular disease.

A possible connection between marijuana abuse and strokes or heart attacks was found in a paper in 2008 (May) by Jayanthi and others. Abnormalities in proteins caused by heavy marijuana use were investigated. A protein, apoC -111 (apolipoprotein C-111) showed significant increases in marijuana users. This is associated with increases in triglycerides. This may be one reason why some marijuana users have an increased risk of stroke and heart attack.

2010 Jouanjus et al looked at cannabis-related hospitalizations among 200 patients admitted to the public hospitals of the Toulouse area of France between Jan 2004 and Dec 2007. They found that one of the adverse events (AE) was lethal. Psychiatric disorders occurred in 57.7%, leading to 18.2% of AEs, central and peripheral nervous system disorders, 15.8%, acute intoxication 12.1%, respiratory system disorders 11.1%, and cardiovascular disorders 9.5%.

2011 April Wolff et al examined 48 consecutive young patients admitted for acute ischemic stroke. They found multi-focal intra-cranial stenosis associated with cannabis use in 21% (10 patients), and concluded that multi-focal angiopathy associated with cannabis consumption could be an important cause of ischemic stroke in young people.

2013 February Wolff, after a new literature review, concluded that cannabis-related stroke is not a myth and cannabis use should be considered as a risk factor inducing ischemic stroke. She said, ‘most cannabis users are young , patients under 45 years of age presenting with symptoms of stroke should be asked about cannabis use and their urine tested for cannabinoids. 59 cases of cannabis-related stroke (mean age 33) were described mostly male ratio male to female 4.9:1. Of the 59, 46 were classified as ischemic stroke, 5 were transient ischemic attacks, one a haemorrhagic stroke and in 4 patients a diagnosis of stroke was suspected but no neuro-imaging was done. In many cases they occurred while smoking or within half an hour.

2013 February 6th Dr Alan Barber (University of Auckland) presented his findings to The American Stroke Association annual meeting in Honolulu. He studied 160 controls and 160 stroke patients, 150 of them with ischemic strokes. 16% of stroke patients had positive cannabis screens compared with only 8% of the controls. This is a doubling of the risk. They were more likely to be male (84%) and tobacco smokers (88%). This is a doubling of the risk for cannabis users.

2013 Professor Joseph Harbison told Dublin Coroner’s Court that St James’s Hospital had seen 5 or 6 cases of young people having strokes following the use of herbal cannabis in the last 3 years. He thought it may be due to the higher strength.

2014 Thomas et al determined what cardiologists need to know. 200 million use cannabis worldwide. Since cannabis is now legal in 2 American States and medical cannabis is available in around 20 others, it is important that cardiologists are aware of the increase in health problems that may occur. These are: myocardial infarction, sudden cardiac death, cardiomyopathy, stroke, transient ischemic attacks, and cannabis arteritis.

2014 Singh and others Looked at a case of atrial fibrillation in an eighteen year old adolescent. An 18 year old with a structurally normal heart presented with prolonged atrial fibrillation (AF) precipitated by new-onset generalised tonic-clonic convulsions and marijuana abuse. This is an interesting

association and a unique pathophysiology between generalised tonic-clonic convulsions, marijuana abuse and AF. Seizures and marijuana abuse should be considered in the differential diagnosis of the etiology of AF in children.

2014 Daldrup et al found that 2 young men had died unexpectedly after smoking cannabis. A 23 year old had a serious undetected heart problem and the 28 year old had abused alcohol, amphetamine and cocaine in the past. 'To our knowledge these are the first cases of suspected fatal cannabis intoxications where full post-mortem investigations..... were carried out'.

2014 Jouanjus et al, looked at all spontaneous reports of cardiovascular complications related to cannabis use collected by the French Addictovigilance Network from 2006 to 2010. 1.8% of all cannabis-related reports (35/1979) were cardiovascular complications, with patients being mostly men (85.7%) and of an average age of 34.3 years. There were 22 cardiac complications (20 acute coronary syndromes), 10 peripheral complications (lower limb or juvenile arteriopathies and Buerger-like diseases), and 3 cerebral complications (acute cerebral angiopathy, transient cortical blindness, and spasm of cerebral artery). In 9 cases, the event led to patient death.

2014 April Casier et al reported cases of 3 patients where recent and/or chronic use of marijuana led to severe cardiac function. All 3 collapsed at home and needed CPR with initial restoration of spontaneous circulation (ROSC). All 3 had used cannabis and no other drug. They concluded: 'Cannabis use can lead to severe cardiovascular problems and sudden death, not only in people at increased cardiovascular risk but also in young people without any medical history or risk factors'.

2014 Lee found migratory superficial thrombophlebitis in a cannabis smoker. A 28-year old man had a 5-year history of recurrent painful subcutaneous nodules in various parts of his body. He developed a 1cm nodule in his right calf which progressed over 2 days to 4cm. This was repeated once/every few weeks in different locations. This was Buerger disease. Tobacco smoking is often considered essential but he denied smoking. A few cases associated with cannabis have been reported.

2014 Wolff and others looked at the high frequency of intracranial arterial stenosis and cannabis use in ischaemic stroke in the young. 159 patients (18-45) admitted for acute ischaemic stroke from Oct 2005 to Dec 2010 were studied. Conclusion: Intracranial arterial stenosis may be an important mechanism of stroke in young patients and should be systematically investigated using vascular imaging. Patients should be strongly questioned about cannabis use. Cannabis use may be associated with critical consequences such as stroke.

2014 Gunawardena et al reported a case of myocardial infarction following cannabis induced vasospasm. A 29 year old man (Sri Lanka) presented with acute coronary syndrome following consumption of 'Kerala Ganja', a much more potent form than the local ganja (marijuana). A diagnosis was made of vasospasm causing myocardial infarction, most likely to have been triggered by cannabis consumption.

2014 Wang et al looked at the damage to blood vessels by secondhand marijuana smoke. Anaesthetised rats were exposed to marijuana SHS (Secondhand smoke). They concluded that marijuana and tobacco SHS impair endothelial function similarly under comparable exposure conditions. Public exposure should be avoided whether tobacco or marijuana smoke.

2015 Hackam investigated cannabis and strokes. Case reports on cannabis and cerebro-vascular events were retrieved. There were 34 case reports on 64 patients. Most of them (81%) exhibited a temporal relationship between cannabis exposure and the index event. In 70% the evaluation was sufficiently comprehensive to exclude other sources for stroke. 22% of the patients had another stroke after subsequent re-exposure to cannabis. Finally half the patients had concomitant stroke risk factors, most commonly tobacco (34%) and alcohol (11%) consumption. They concluded that many case reports support a causal link between cannabis and cerebro-vascular events.

2015 Rumalla et al looked at hospitalizations for aneurysmal sub-arachnoid haemorrhage (aSAH). The Nationwide Inpatient Sample, 2004-2011 was used. They concluded that 'Our analysis suggests that recreational cannabis use is independently associated with an 18% increase likelihood of aSAH'. It was more frequent in younger male patients.

2016 Wang et al looked at second-hand marijuana smoke (SHS) exposure and vascular endothelium functioning. Endothelial function was measured as femoral artery flow-mediated dilation (FMD) in rats. One minute of exposure to SHS of marijuana impaired FMD to a comparable extent as impairment from equal concentrations of tobacco SHS but recovery was considerably slower.

2016 Singh et al found that marijuana use may be linked to temporarily weakened heart muscle. 'Active marijuana use may double the risk of stress cardiomyopathy, an uncommon heart muscle malfunction that can mimic heart attack symptoms'. The heart's ability to pump leads to chest pain, shortness of breath, dizziness and sometimes fainting. 33,343 people hospitalised with the condition from 2003-2011 in the USA were studied. Less than 1% were cannabis users (210). These users were significantly more likely to go into cardiac arrest (2.4% v 0.8% (non-users), and require a defibrillator. "Marijuana users were more likely than non-users to have a history of depression (32.9 percent vs. 14.5 percent), psychosis (11.9 percent vs. 3.8 percent), anxiety disorder (28.4 percent vs. 16.2 percent), alcoholism (13.3 percent vs. 2.8 percent), tobacco use (73.3 percent vs. 28.6 percent) and multiple substance abuse (11.4 percent vs. 0.3 percent). Because some of these can increase the risk of stress cardiomyopathy, the researchers adjusted for known risk factors to investigate the association between marijuana use and stress cardiomyopathy."

2016 Reece and others looked at cannabis exposure as an interactive cardiovascular risk factor and accelerant of organismal ageing. 11 cannabis-only smokers, 504 tobacco-only users, 114 tobacco and cannabis users and 534 non-smokers were studied over a 5 year period. They discovered that long-term use of cannabis increased the biological age of those studied by 11% due to the impact of hardening of the arteries e.g. a thirty year old would have a biological age of 33. Associate Professor Stuart Reece said that the results showed that, 'not only does it age you, it increases ageing at an exponential rate over time which is alarming'.

2016 Draz et al Looked at marijuana use in acute coronary syndromes. 138 male patients, around 40 years of age with acute myocardial infarction were studied. Urine samples were submitted for toxicological analysis. None of group 1 (cannabis positive only) had normal coronaries. Significant changes in echocardiography and angiography were found between group 1 and the other groups – group 2 (patients positive for other substance abuse) and group 3 (Negative for any substance abuse). 'Cannabis smoking could be a potential risk factor for the development of cardiac ischemia'.

References

Barber A, *Smoking Pot May Raise Stroke Risk in Young Adults*

Presentation February 2013 to The American Stroke Association annual meeting in Honolulu..

Benowitz NL and Jones RT, 1975 *Cardiovascular effects of prolonged delta-9-tetrahydrocannabinol ingestion*. *Clinical Pharmacology and Therapeutics*; 18: 287-297

Carter WE, Coggins W, Doughty PL, 1980 *Cannabis in Costa Rica: A study of chronic marijuana use*. Philadelphia: Institute for the Study of Human Issues.

Casier I, Vanduyndhoven P, Haine C, Jorens PG. *Is recent cannabis use associated with acute coronary syndromes? An illustrative case series*. *Acta Cardiol*. 2014 April; 69(2): 131-6

Charbonney E, Sztajzel J-M, Poletti P-A, Rutschmann O, *Paroxysmal atrial fibrillation after recreational marijuana smoking: another "holiday heart"?* *Swiss Med Weekly* 2005;135:412-4.

Choi YS and Perl WR, 1989 *Cardiovascular effects of adolescent drug use*. *Journal of Adolescent Health Care* 10: 332-337.

Daldrup T, Hartung B, Kaufenstein S, Ritz-Timme S. Sudden unexpected death under acute influence of cannabis. *Forensic Science International*. 2014. DOI:[10.1016/j.forsciint.2014.02.001](https://doi.org/10.1016/j.forsciint.2014.02.001)

Draz EI, Oreby MM, Elsheikh EA, Khedr LA, Atlam LA, Marijuana use in acute coronary syndromes. *Am J Drug Alcohol Abuse*. 2016 Nov 7th 1-7.

Gawin FH, Ellinwood EH, 1988 *Cocaine and Other Stimulants: Actions Abuse and Treatment* New England Journal of Medicine 318: 1173-1182

Geller T, Loftis L, Brink D, 2004 *Cerebellar Infarction in Adolescent Males Associated with Acute Marijuana Use* Pediatrics; 113: 365-70

Gunawardena MD, Raja-akse S, Herath J, Amarasena N, Myocardial infarction following cannabis induced coronary vasospasm. BMJ Case Rep. 2014 Nov 12;2014. pii: bcr2014207020. doi: 10.1136/bcr-2014-207020.

Hackam DG, Cannabis and Stroke: Systematic Appraisal of case reports. STROKEAHA 115.008680 DOI: 10.1161/STROKEAHA.115.008680

Herning RI, Better WE, Tate K, Cadet J, 2001 *Marijuana Users are at Increased Risk for Stroke* Annals of the New York Academy of Sciences 939 :413-5

Huber GL, Griffith DL, Langsjoen PM, 1988 *The effects of marijuana on the respiratory and cardiovascular systems*. In G Chesher, P Consroe, R Musty editors, *Marijuana: An International Research Report*. National Campaign Against Drug Abuse Monograph Number 7, Canberra: Australian Government Publishing service.

Jayanthi S, Buie S, Moore S, Herning R, Better W, Wilson NM, et al *Heavy Marijuana Users Show Increased Serum Apolipoprotein C-111 levels: Evidence from proteomic analysis*. *Molecular Psychiatry advance online publication 13 May 2008*.

Jones RT 1984 *Cardiovascular effects of cannabinoids*. In DJ Harvey, W Paton and GG Nahas, editors, *Marijuana '84: Proceedings of the Oxford Symposium on Cannabis*, Oxford: IRL Press

Jones RT, 2002 *Cardiovascular System Effects of Marijuana* Journal of Clinical Pharmacology 42:58-63.

Jones RT and Benowitz N, 1976 *The 30-day trip clinical studies of cannabis tolerance and dependence* in M Braude and S Szara editors, *Pharmacology of Marijuana*. Volume 2 New York: Academic Press.

Jouanous E, Leymarie F, Tubery M, Lapeyre-italisations: *Cannabis-related hospitalisations: Unexpected serious events identified through hospital data bases*. *British Journal of Clinical Pharmacology* 2010 Accepted article doi: 10.1111/1365-2125.2010.03897.x

Joujanus E, Lapeyre –Mestrie M, Micallef J, *Cannabis Use: Signal of Increasing Risk of Serious Cardiovascular Disorders* *Journal of the American Heart Association* April 23rd 2014; 3:e000638 2014 doi: 10.1161/JAHA.113.000638

Korantzopolous P, Liu T, Papaioannides D, Li G, Goudevenos JA *Atrial fibrillation and marijuana smoking*. *Internat. Journal of Clinical Practice* Feb. 2008; 62(2): 308-313.

Kosior DA et al, 2001 *Paroxysmal Atrial Fibrillation Following Marijuana Intoxication: A Two-Case Report of Possible Association* *International Journal of Cardiology*. 78(2): 183-4.

Lindsay AC, Foale RA, Warren O, Henry JA, *Cannabis as a precipitant of cardiovascular emergencies*. *International journal of Cardiology* 2005; 104(2) 230-2.

Lee C, Moll S, Migratory Superficial Thrombophlebitis in a Cannabis Smoker. *Circulation*.2014; 130: 214-215doi: 10.1161/CIRCULATIONAHA.114.009935

Mach F, Steffens S et al 2005 *Low dose oral cannabinoid therapy reduces progression of atherosclerosis in mice*. *Nature* 434:782-6.

Mateo I, Pinedo A, Gomez-Beldarrain M, Basterretxea JM, Garcia-Monco JC, 2005 *Recurrent stroke association with cannabis use*. Journal of Neurology, Neurosurgery and Psychiatry March 2005. 76:435-7.

Maykut MO, 1984 *Health Consequences of Acute and Chronic Marijuana Use*
Oxford: Pergamon Press.

McLeod L, McKenna CJ, Northridge DB, *Myocardial infarction following the combined recreational use of Viagra and cannabis*. Clinical Cardiology 2002; vol 25 (3) pp 133-4.

Mittleman MA, Lewis RA, Maclure M, Sherwood JB, Muller JE, 2001 *Triggering Myocardial Infarction by Marijuana* Circulation:103 (23): 2805-9.

Moussouttas M, Jan 2004 *Cannabis Use and Cerebrovascular Disease*
Neurologist 10(1): 47-53.

Mukamal KJ, Maclure M, Muller JE, Mittleman MA, An exploratory prospective study of marijuana use and mortality following acute myocardial infarction. American heart Journal March 2008; 155(3): 465-70.

Nowlan R, Cohen S, 1977 *Tolerance to marijuana: heart rate and subjective "high"*.
Clinical Pharmacology and Therapeutics 22: 550-6.

Perl W, Choi YS, 1992 *Marijuana as a cause of myocardial infarction* International Journal of Cardiology 34:353-4.

Podczeck A, Frohmer K, Steinbach K, 1990 *Acute Myocardial Infarction in juvenile patients with normal coronary arteries* International Journal of cardiology 30: 359-361.

Reece AS, Norman A, Hulse GK. Cannabis Exposure as an interactive cardiovascular risk factor and accelerant of organismal ageing: a longitudinal study. BMJ Open 2016;6:e011891 doi:10.1136/bmjopen-2016-011891

Rubin V, and Comitas L, 1975 *Ganja in Jamaica: A Medical anthropological Study of Marijuana Use*
The Hague: Mouton Publishers.

Rumalla K, Reddy AY, Mittal MK, Association of Recreational Marijuana Use with Aneurysmal Subarachnoid Hemorrhage. J Stroke Cerebrovasc Dis. 2015 Dec 18. pii: S1052-3057(15)00571-6. doi: 10.1016/j.jstrokecerebrovasdis.2015.10.019. [Epub ahead of print]

Sidney S, 2002 *Cardiovascular Consequences of Marijuana Use*
Journal of Clinical Pharmacology 42: 64-70.

Singh D, Huntwork M, Shetty V, Sequeira G, Akingbola O, *Prolonged Atrial Fibrillation Precipitated by New-Onset Seizures and Marijuana Abuse*.
Pediatrics 2014 Feb; 133(2): e443-e446 Epub 2014 Jan 13.

Singh A, Fegley M, manda Y, Nanda S, Shirani J, Marijuana use maybe linked to temporarily weakened heart muscle. American Heart Association Meeting Report – Poster:S4054 – Session: HF.APS.P14 November 13th 2016

Stefanis C, Dornbush R, Fink M, editors 1977 *Hashish: Studies of Long-Term Use*.
New York: Raven Press.

Steffens S, Mach F, *Towards a therapeutic use of selective CB2 cannabinoid receptor ligands for atherosclerosis*. Future Cardiology 2006; 2 (1) 49-53.

Thomas G, Kloner RA, Rezkalla S, *Adverse cardiovascular, cerebrovascular, and peripheral vascular effects of marijuana inhalation: what cardiologists need to know*
Am J Cardiol 2014 Jan 1;113(1):187-90.doi: 10.1016/j.amjcard.2013.09.042. Epub 2013 Oct 5.

The Crawley News (Trinity Mirror PLC) 12/07/06, available at www.icsurreyonline.co.uk

Wang X, Derakhshandeh R, Narayan S, Luu E, Le S, Danforth OM, et al. Brief Exposure to Marijuana Second-hand Smoke Impairs Vascular Endothelial Function. American Heart Association Scientific Sessions 2014

Wang MD, Derakhshandeh R, Liu J, Narayan S, Nabavizadeh P, Le S, Danforth O, ...Springer ML. One Minute of Marijuana Second-Hand Smoke Exposure Substantially Impairs Vascular Endothelial Functioning. J Am Heart Association 2016;5:e003858. DOI: 10.1161/JAMA.116.0033858

Wolff V, Lauer V, Rouyer O, Sellal F, Meyer N, Raul JS, Sabourdy C, Boulan F, Jahn C, Beaujeux R, Marescaux C, *Cannabis Use, Ischemic Stroke, and Multifocal Intracranial Vasoconstriction: A Prospective Study in 48 Consecutive Young Patients*. Stroke 2011 Apr 21. [Epub ahead of print]

Wolff V, Armspach JP, Lauer V et al, *Cannabis-related Stroke: Myth or reality?* Stroke 2013; 44: 558-563

Wolff V, Armspach JP, Beaujeux R, Manisor M, Pouyer O, Lauer V, et al, High Frequency of intracranial arterial stenosis and cannabis use in ischaemic stroke in the young. Cerebrovasc. Disc. 2014;37(6):438-43. do:10.1159/0003636118. Epub 2014 Jul 23rd.

