

STROKE IN INDIA

Fiona C Taylor

South Asia Network for Chronic Disease

Background

Stroke is one of the leading causes of mortality and morbidity worldwide. Approximately 20 million people each year will suffer from stroke and of these 5 million will not survive. (Dalal et al 2007) Developing countries account for 85% of global deaths from stroke (Gupta et al 2008). Stroke is also a leading cause of functional impairments, with 20% of survivors requiring institutional care after 3 months and 15% - 30% being permanently disabled. (AHA 2009) Stroke is a life-changing event that affects not only the person who may be disabled, but their family and caregivers. Utility analyses show that a major stroke is viewed by more than half of those at risk as being worse than death. (AHA 2006) Effective screening, evaluation, and management strategies for stroke are well established in high-income countries, (Bath and Lees 2000) but these strategies have not been fully implemented in India. (Pandian 2007)

This chapter will provide a description of stroke and present the distribution, prevalence and incidence of stroke in India. The burden of stroke in India will be explored. Risk factors for stroke, co-morbid conditions, best management practice and treatment of stroke will be also included. Current stroke policy, stroke research programs in India, and gaps in knowledge of stroke research will also be reviewed.

Morbidity and Mortality associated with Stroke

Global Stroke Morbidity and Mortality

- 400-800 strokes per 100,000 (Banarjee 2005)
- 5.7 million deaths (Sridharan 2006)
- 15 million new acute strokes every year (Shah + Mathur 2006)
- 28,500,000 DALYs (disability adjusted life-year) (WHO 2004)
- 28-30 day case fatality ranges from 17%-35% (Feigin et al 2009)

Stroke Morbidity and Mortality in India

- Prevalence 55.6 per 100,000 all ages (Dalal 2007)
- 0.63 million deaths (WHO 2005)
- 1.44-1.64 million cases of new acute strokes every year (WHO 2005, Murthy 2007)
- 6,398,000 DALYs (WHO 2009)
- 12% of strokes occur in the population aged <40 years (Shah + Mathur 2006)
- 28-30 day case fatality ranges from 18-41% (Dalal et al 2008, Das et al 2007)

What is stroke?

Stroke, or a cerebral vascular accident, is the sudden death of brain cells due to inadequate blood flow. The WHO clinically defines stroke as the rapid development of clinical signs and symptoms of a focal neurological disturbance lasting more than 24 hours or leading to death with no apparent cause other than vascular origin'. (WHO 2005) Stroke is a clinical syndrome divided into two broad categories that define its pathophysiology:

1) *Ischaemic strokes* are caused by either cerebral thrombosis or embolism and account for 50%–85% of all strokes worldwide. (Feigin et al 2009)

2) *Haemorrhagic strokes* are caused by subarachnoid haemorrhage or intracerebral haemorrhage and account for 1%-7% and 7%-27% respectively of all strokes worldwide. (Feigin et al 2009)

The effects of a stroke are determined by the extent and site of brain injury, but the clinical symptoms of stroke do not accurately predict its underlying cause or causes. Classic stroke symptoms include the acute onset of unilateral paralysis, loss of vision, speech impairment, memory loss, impaired reasoning ability, coma, or death. (Bath and Lees 2000) Death rates for the different types of stroke are illustrated in the Box 1.

Box 1: Death rate (percentage) 30 days, 1 year, and 5 years after different types of stroke

	30 days	1 year	5 years
Ischaemic stroke	10	23	52
Intracerebralhaemorrhage	52	62	70
Subarachnoid haemorrhage	45	48	52

(Bath et al 2000)

About one-third of all strokes are preceded by transient ischemic attacks (TIAs), or mini-strokes, which temporarily interrupt blood flow to the brain. While TIAs cause similar symptoms, the clinical symptoms resolve in less than 24 hours, though typically much more quickly. (Bath et al 2000)

The distribution, prevalence and incidence of stroke in India

Reliable morbidity and mortality estimates for stroke in India are limited due to incomplete death certification, incorrect death classification, and uncertainty of aetiology in cases of sudden death or multiple co-morbidities. (Sethi et al 2007) In India, although a system for recording cause of death was introduced in 1998, only 14% of deaths are ever classified. (Central Bureau of Health Intelligence, India 2007) These data indicate that death from diseases of the circulatory system (of which stroke is a subset) comprised 24% of all deaths between 1998-1999. (Central

Bureau of Health Intelligence, India 2007) Other estimates from the Andhra Pradesh Rural Health Initiative suggest that cerebrovascular disease led to 13% of total deaths in 2005, however this may be an underestimation since prevalence of stroke in India is higher in urban compared with rural areas. (Joshi et al 2006, Bannerjee + Das 2006) National time-trend estimates are not readily available in India for stroke. However the Indian Council for Medical Research estimated that mortality due to strokes increased by 8% between 1998-2004. (Shah + Mathur 2006)

World-wide over the past four decades, the annual age-standardised stroke incidence rate has decreased by 1.1% in high-income countries but has increased by 5.3% in low to middle income counties. (Feigin 2009) In India, the Indian National Commission on Macro-economics and Health estimated that the number of strokes will increase from 1,081,480 in 2000 to 1,667,372 in 2015, (Shah + Mathur 2006) The Global Burden of Disease Study projects that total deaths from stroke in India will surpass established market economies by year 2020. (Table 1)

Table 1: Death from cerebrovascular disease in India, China and established market economies (EME) in millions (abridged from Ezzati et al 2004)

1990			2000			2010			2020		
India	China	EME	India	China	EME	India	China	EME	India	China	EME
0.45	1.27	0.79	0.6	1.65	0.87	0.75	1.91	0.88	0.95	2.29	0.91

Prevalence/incidence of stroke in India

Prevalence data for stroke are limited (figures 1 + 2) and are confined to studies that suffer from frequent bias, small and variable sample sizes, and inconsistent diagnostic criteria. (Gupta 2008) The crude prevalence rate for India indicates variations according to region (figures 1 and 2).

Table 2 indicates that the crude prevalence rate appears to be higher in urban compared to rural populations. The Parsi population in Mumbai appears particularly at risk, compared with the Indian population. The Parsi people migrated from Iran in the 7th century to India it is argued that they are ethnically distinct from the Indian population. (Banarjee + Das 2006). Whilst marriage outside their community is prohibited, the rates for prevalence and incidence of stroke are similar to that of developed countries. (Bharucha et al 1988, Bharucha + Kuruvilla 1998) For India, the overall age adjusted prevalence rate for stroke is estimated to lie between 84-262/100,000 in rural and between 334-424/100,000 in urban areas.

Whilst individual studies have reported varying annual incidence rates for stroke (table 3), the Global Burden of Disease Study estimated a population-based annual stroke incidence of India to be 89/100,000 in 2005, which is projected to increase to 91/100,000 in 2015 and to 98/100,000 in 2030. (Ezzati et al 2004)

Figure 1: Crude prevalence rates for stroke rural India 1970-2004

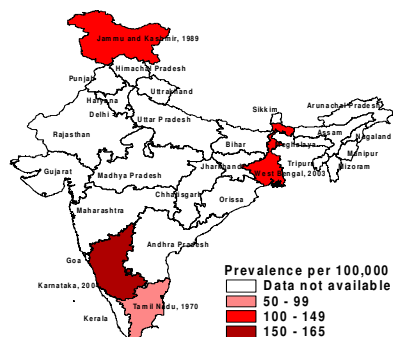
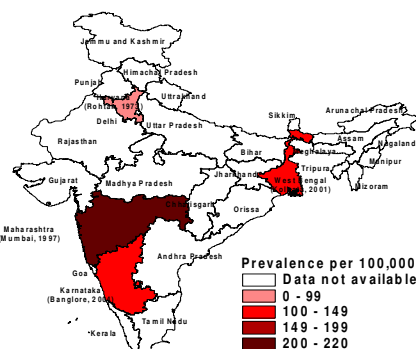


Figure 2: Crude prevalence rates for stroke urban India 1973-2004



Stroke increases with age: individual Indian studies have estimated that the prevalence rates increases from 21/100,000 for the 20-40 age group to 625/100,000 in the 60+ year age group. (Dhamija et al 2000) Similarly, the incidence rates increase from 27-34/100,000 in the 35-44 age group to 822-1116/100,000 in the 75+ age group. (Dalal et al 2008, Sridharan et al 2009) However in India, the prevalence of stroke in younger individuals is high (18-32% of all stroke cases) compared with high-income countries. (Dalal et al 2008)

Table 2: Stroke prevalence studies in India (Gupta et al 2008)

First author	Year	Location	Sample size	Crude prevalence/ 100,000	Age-adjusted prevalence/100 000
Urban					
Bansal BC	1973	Rohtak	79 046	44	–
Bharucha NE	1988	Mumbai Parsi	14 010	842	424
Dalal PM	1997	Mumbai	145 456	220	–
Banerjee TK	2001	Kolkata	50 291	147	334
Gourie-Devi M	2004	Bangalore	51 502	136	–
Rural					
Abraham J	1970	Tamil Nadu	258 576	57	84
Gourie-Devi M	1987	Karnataka	57 660	52	–
Razdan S	1989	Kashmir	63 645	143	244
Das SK	1996	West Bengal	37 286	126	–
Saha SP	2003	West Bengal	20 842	147	–
Gourie-Devi M	2004	Karnataka	51 055	165	262

Table 3: Annual incidence rates for stroke in India (Dalal et al 2008, Banerjee + Das 2006)

First author	Year	Location	Sample size	Annual incidence/ 100 000	Age-adjusted annual incidence/100,000
Urban					
Banerjee TK	2001	Kolkata	50 291	36	105*
Dalal PM	2005	Mumbai 1	56 861	145	152
Sridharan	2009	Trivandrum	741000	116	135
Rural					
Abraham J	1970	Tamil Nadu	258 576	13	-
Sridharan	2009	Trivandrum	185000	119	138
Battacharya S	2005	West Bengal	20 842	124	262**

*Age-adjusted to 1996 US population, ** Age-adjusted to 1990 US population

Men are more likely to have a stroke than women: the male/female sex ratio for India is 7:1. (Sethi 2002) This may be due to differences in risk factors such as smoking and drinking which are more prevalent among men in India compared with women. (Das + Banerjee 2008) The mean onset of stroke for men in India ranges from 63-65 for men and 57-68 for women. (Bhattcharya et al 2005, Dalal et al 2008, Sridharan et al 2009)

Low socio-economic status is associated with atherosclerosis but this may be primarily mediated by higher burden of risk factors including smoking, high blood pressure, heavy alcohol consumption and diet. (Tripathy et al 2007) Although there is much data in India to suggest that higher socio-economic status is associated with higher rates of cardiovascular disease, no such data exists for stroke. (Pandian et al 2007) Das et al demonstrated that the incidence and prevalence of stroke was greater among slum dwellers in Kolkata than in non-slum dwellers, but the difference was not statistically significant. (Das et al 2007) Tripathi et al were able to identify that the prevalence of risk factors such as hypertension and hypercholesterolemia were 7% and 10% higher respectively among the low-income urban population of Chennai compared with the middle-income population. In addition, the prevalence of smoking was more than double among those with less than 10 years of schooling compared with those with more than 16 years of schooling: 24% and 54% respectively. (Tripathi et al 2007)

Overall burden of stroke in India

Where stroke mortality rates are declining or stabilising in developed countries, experts are concerned of the emerging stroke epidemic of stroke in India. (Dalal et al 2007) As life expectancy is projected to increase, India will likely face a significant socioeconomic burden to meet the costs of managing stroke. (Dalal et al 2008) In 1998, it was estimated that strokes accounted for 0.9% to 4.5% of total medical admissions and 9.2%-30% of admission to neurological wards. (Bharucha+Kuruvilla 1998) More recently it has been estimated that 12% of all strokes occur in those less than 40 years: previous stroke is a major risk factor for stroke for those aged more than 65. (Mackay et al 2004, Pandian et al 2005) Utility analysis undertaken in the developed world indicates that major stroke is viewed by more than half of those at risk being worse than death. (AHA 2006)

The economic burden caused by stroke has not been explored in India. (Pandian et al 2007) However, India is estimated to have lost 8.7 billion 1998 international dollars in 2005 due to coronary heart disease (CHD), stroke, and diabetes. This is to increase to 54 billion 1998 international dollars by 2015 and India's growth of gross domestic product (GDP) is estimated to fall by 1% because of the combined economic impact of CHD, stroke, and diabetes. (WHO, 2005)

The estimated life years lost due to stroke was 5,289,357 in 2004, an increase from the 1998 estimate of 4,818,740. (WHO 2005)

Disability Adjusted Life Years (DALY): A recent study indicated that national per-capita income was the strongest predictor of stroke mortality and DALY loss even after adjustment for cardiovascular risk factors. (Jeffrey 2009) In 1997, it was estimated that 28.5 million DALYs were lost due to stroke worldwide; nearly 6 times higher than that of malaria. (Dalal et al 2007) This is projected to increase to 61 million DALYs in 2020. Eight-four per cent of these DALYs lost will be in developing countries. (Dalal et al 2007) In South East Asia alone, where India comprises 81% of the population, 6.36 million DALYs are estimated to be lost due to stroke. (Gupta 2008)

Risk factors for stroke among the Indian population

Three transitions have contributed to the emergence of the stroke epidemic in India: demographic, lifestyle and socioeconomic. (Dalal et al 2007, Pandian et al 2007, Gupta et al 2008) The demographic shift is characterised by increased life expectancy, lifestyle by a shift in food consumption and less physical activity and socio economic by a raise in living standards by an urban elite who adopt western lifestyles. (Reddy 2004) The resulting effect of these transitions increase risk factors for stroke, many of which are modifiable.

Non-modifiable stroke risk factors include, age, sex, low birth weight, ethnicity and genetic factors, but modifiable risk factors include smoking, hypertension, and high cholesterol (table 4). (AHA 2006) Few studies estimate the risk factors for stroke among the Indian populations, but of the available data, Table 4 illustrates the prevalence of these risk factors, odds ratios and the population attributable risk proportion. As comparison, odds ratio of modifiable risk factors are also provided for the United States (US) population, for example; heart disease and smoking appear to be greater risk factors for the Indian compared with the US population.

Risk assessment tables

Although stroke risk assessment tools exist, the complexities of the interaction between risk factors and the effects of certain risk factors stratified by age, gender, ethnicity and geography are incompletely captured by a global risk assessment tool. (AHA 2006) The widely used Framingham Stroke Profile developed in the US is criticized for its validity among individuals of different age ranges or of different ethnic groups. (AHA 2006) For example, a study applied the Framingham Stroke Profile to different ethnic groups in the United Kingdom and found that the application of the hypertension guidelines to people with uncomplicated mild hypertension might lead to under-treatment of people of south Asians and African origin who would not be considered for drug therapy despite a high risk of combined stroke. (Cappuccio et al 2002)

Table 4: Risk factors of stroke among the Indian population

Study	Prevalence of risk factors, India	Odds ratio, India			Odds ratio, US	PARP India
		Bhattachaya All ages	Lipsaka <45 years	Zodpey All ages		
Alcohol consumption	22.5% #			1.96	1.8	0.09
Diabetes	3% -12%	1.73		2.39	1.8	
Family history of stroke	8% †					
Heart disease	7% with AF*	6.20		3.4	1.73	
High cholesterol	7%-32%		0.2 per SD increment	2.27	2.0	0.14
Hypertension	12-40%	2.79	1.9 per SD increment	1.99	1.0-4.0	0.17
Obesity	6%-49%			1.91	1.75-2.37	
Past history of TIA				8.44		0.08
Smoking	13% (women) 46% (men)	3.92	7.8	1.11	1.9	

PARP= population attributable risk proportion; AF=atrial fibrillation, *Sridharan et al 2009; †Bhattacharya 2005, #Shah 2005

Recommended management and treatment of stroke

In general, the generation and implementation of priority-setting guidelines for practice is an important step in operationalising evidence. (Lyons et al 2008) The guidelines are best when need, effect size and evidence for stroke are considered and if they include additional elements of care in a number of areas including emergency medical services and intensive care discharge. Research on guideline utilization indicates that having written policy and practice guidelines can improve compliance with best practice. (Lyons et al 2007) In India, a recent World Bank project on primary health provision in New Delhi highlighted:

- a) The association between low competency among doctors with poor quality of medical care.
- b) The gap between physician knowledge and physician practice.
- c) The association between payment scheme (fee-for-service versus fixed salary) and continuing medical education.

(Das and Hammer 2005)

Acute treatment

Proven treatments of acute thrombotic stroke includes intravenous thrombolysis within 3 hours of onset of symptoms, use of aspirin 48 hours and decompressive surgery for malignant middle cerebral artery infarction. (Pandian 2008) Surgery for haemorrhage due to aneurysm may be performed. For aneurysms that are difficult to reach surgically, endovascular treatment, in which a catheter is guided from a larger artery into the brain to reach the aneurysm, may be effective. (Bath and Lees 2000) Management of stroke patients in stroke units has also been shown to be effective in terms of recovery and return to active life. (Panadian 2008)

Symptoms and signs of stroke (Bath et al 2000)

Anterior circulation strokes

- Unilateral weakness, sensory loss or inattention
- Isolated dysarthria
- Dysphasia
- Vision: Homonymous hemianopsia, monocular blindness, visual inattention

Posterior circulation strokes

- Isolated homonymous hemianopia
- Diplopia and disconjugate eyes
- Nausea, vomiting, inco-ordination and unsteadiness
- Unilateral or bilateral weakness and/or sensory loss

Non-specific signs

- Dysphagia, incontinence, loss of consciousness

Complications of stroke (Bath et al 2000)

- Hyperglycaemia
- Hypertension
- Fever
- Infarct extension or re-bleeding
- Cerebral oedema, herniation, coning
- Aspiration
- Pneumonia
- Urinary tract infection
- Cardiac dysrhythmia
- Recurrence
- Deep vein thrombosis, pulmonary embolism

Primary prevention is particularly important because >70% of strokes are first events. (AHA 2006) The age-specific incidence of major stroke in Oxfordshire, UK, fell by 40% over a 20-year period in association with an increased use of preventive treatments and general reductions in cerebrovascular risk factors. (AHA 2006) It has been estimated that a 2% reduction in overall

stroke mortality in India would result in 6.4 million fewer deaths over a 10 year-period. (Pandian et al 2007) Interventions should be targeted at behavior modification such as reduced smoking, alcohol and salt consumption patterns (~5mg of salt intake increases the risk of stroke 23% [Strazzullo et al 2009]), increasing fruit and vegetable consumption (for each 1-serving per day increment in fruit and vegetable consumption, the risk of stroke is reduced by 6% [AHA2006]) and physical activity. (AHA 2006, Dalal 2007, Gupta et al 2008)

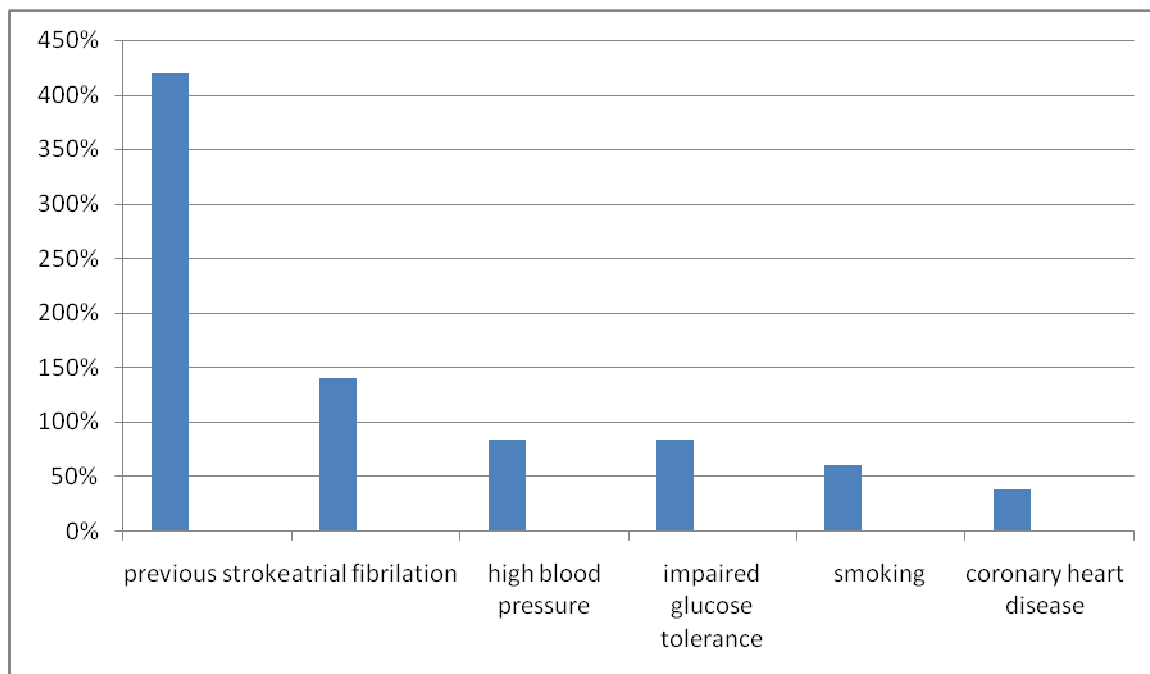
Secondary prevention strategies include pharmacotherapy with aspirin, dipyridamole, clopidogrel. (Adams et al 2008) An early multi-centre trial was able to establish that aspirin alone reduces the risk of continuing ischemic attacks, stroke or death by 19% and also reduces risk of stroke or death by 31%. (Canadian Cooperative Study Group 1978) and there a currently ongoing trials to test is if this is true some 40 years later (Aspirin Dose Optimized in Non-Cardioembolic Ischemic Stroke Trial, Aspirin to reduce the risk of initial vascular events Trial). (Internet Stroke Center) More recent evidence suggests that a 24% risk reduction of death from all vascular causes can be achieved with of use aspirin and dipyridamole, however caution is required with dipyrimole as it is not well tolerated by patients. (AHA 2008)

Effective management of co-morbidities such as hypertension and atrial fibrillation is also necessary. For example, reductions of stroke with the use of (AHA 2006, Gupta et al 2008):

- Anti-hypertensive drugs is estimated to be 35-44%.
- Anticoagulants for atrial fibrillation is estimated to be 20-45%.
- Statins for high cholesterol is estimated to be 20%.

The most common predictors of death from stroke for those aged more than 65 of age include previous stroke and atrial fibrillation (Figure 3).

Figure 3: Predictors of death from stroke (Mackay 2004)



Stroke rehabilitation refers to a comprehensive program designed to regain as much function as possible and compensate for permanent losses. In high-income countries, the evidence suggests that 10% of stroke survivors are without any significant disability and able to function independently. Another 10% are so severely affected that they must remain institutionalized for severe disability; the remaining 80% can return home with appropriate therapy, training, support, and care. Rehabilitation may be complicated by cognitive losses, including diminished ability to understand and follow directions. Poor results are more likely in patients whose strokes have left them with significant or prolonged cognitive changes, sensory losses, language deficits, or incontinence. (Bath and Lees 2000)

Management and treatment of stroke in India

In most developing countries, total state health spending is low and in India, less than 20% of total health expenditure is public. (Truelsen 2008) Well-organized stroke services are severely lacking in the government sector of India, and most stroke centers are situated in the private and urban settings in India, when 70% of the population lives in rural areas. (Murthy 2005, Pandian et al 2007, Sethi et al 2007) As such, modern acute stroke care (with optimal use of intensive care units, neuro-imaging, thrombolytic evaluation, monitoring and intensive rehabilitation) appears beyond the reach of most patients. (Dalal 2007) In addition, the availability for continuous medical control of major stroke risk factors such as hypertension, atrial fibrillation, and hyperlipidemia is beyond the capacity of what the public health system is able to provide. (Truelsen 2008) It has been widely discussed that with infectious disease still endemic, non-communicable disease are a low priority raising the ethical dilemmas in diverting scarce health care resources from control of infectious and nutrition disorders to the control stroke and cardiovascular diseases. (Dalal et al 2007, Joshi et al 2006)

The evidence of the management and treatment of stroke in India is confined to small studies, but these highlight issues of lack of access, facilities and provision and lack of knowledge of stroke symptoms in the Indian population. For example:

- The approximate cost of secondary prevention of stroke in India was estimated in 2007 to be 500 INR (US \$10) per month on the premise of prescribing a statin, two anti-hypertensive agents, and one antiplatelet agent per day. However, even these direct costs are prohibitive for most Indians in light of recent World Bank estimates whereby 75.5% of the Indian population is earning less than \$2 per day and 41.6% less than \$1.25 per day. (Prabhakaran + Ajay 2009)
- The cost of thrombolysis, commonly 75mg tissue plasminogen activator (tPA), in 2006 was 55,000 Indian Rupees (US\$ 1,217). (Murthy 2007) It has been argued that most state governments in India are not in a position to provide free thrombolysis and a number of studies have indicated that those eligible for thrombolysis when reaching the hospital were unable to pay for treatment (Murthy 2007, Pandian et al 2007)
- An urban, hospital-based study indicated that the median time from onset of stroke to arrival at hospital was 7.6 hours and that only 25% of patients presented to hospital within 3 hours of stroke. (Srivastava + Prasad 2001) In comparison, a similar study

undertaken in a rural area identified that the mean arrival time of stroke patients to hospital was 34+/-6 hours. (Das + Banerjee 2008) Living in a city, presence of family history of stroke and older age were all positively associated with early arrival. (Murthy 2007) Additionally, one study identified that late arrival was associated to lack of transportation with only 12% reaching the hospital by ambulance and 17% by bicycle or rickshaw. (Pandian et al 2007)

- Bhattachaya et al (2005) demonstrated that among individuals identified in rural Bengal as having had stroke, only 50% had received immediate attention and 74% had received medical attention within the first 30 days of onset. At one-year follow-up of stroke patients, 31% required daily support, 7% were bed-ridden and recovery of speech was documented in only 47% of cases. The authors were also able to demonstrate that women received less medical attention following stroke compared to men despite harbouring the same risk factors. (Bhattachaya et al 2005) More recently, the Trivandrum Stroke Registry was able to establish that of those with stroke, 43% at follow-up were moderately disabled and 15% were bed-ridden. (Sridharan et al 2009)
- Knowledge of symptoms of stroke within in Indian population is poor. In a study in Northwest India, 27% of patients with stroke had recognised that their symptoms were due to stroke. (Pandian et al 2007) Further evidence suggests that only 55% of an unaffected (of stroke) population in both rural and urban settings was able to recognize one warning symptom of stroke, and that only 6.2% could identify 3 symptoms. (Das + Banerjee 2008) Further analysis confirmed that socio-economic status and higher education was associated with knowledge of warning signs. Lack of knowledge inevitably leads to a delay in receiving medical treatment.

Stroke research programmes in India

For preventive strategies to be planned and evaluated, basic epidemiologic surveillance data are first needed. In India a number of recent initiatives have been launched to address this issue.

WHO STEPS programme: The Global Stroke Initiative launched by the WHO provides guidance through its STEPS program to generate population-based data on burden of stroke and to use such data to develop strategies for prevention and management. (Bonita et al 2004, WHO STEPS 2009) Since 2004, the STEPS programme is currently being implemented in various sites in India through the Indian Collaborative Acute Stroke Study. The initial data supports the high prevalence of vascular risk factors and the relatively young age of stroke cases in India. (Shah 2005, Dalal et al 2008, Shah + Mathur 2006, Sridharan et al 2009).

INTERSTROKE: This large, international case-control study in high, middle and low-income countries has been developed to determine the importance of established and emerging risk factors for stroke on a global population, as was conducted for INTERHEART. In India, there are more than 60 centers based in both rural and urban areas collaborating with the INTERSTROKE Study, which began enrolling patients in 2008.

INSPIRE : The Indian Stroke Prospective Registry (INSPIRE) is a large, multi-centre prospective pilot registry whose objective is to determine etiologies, clinical practice patterns and outcomes of strokes in India. INSPIRE is sponsored by the Division of Clinical Trials, St John's Research Institute, Bangalore and began enrolling patients in 2009. (St John's Research Institute 2008)

PURE: The Prospective Urban Rural Epidemiology (PURE) study is a large-scale epidemiological study that plans to recruit approximately 140,000 individuals residing in >600 communities in 17 low-, middle-, and high-income countries around the world. Individual data collection includes medical history, lifestyle behaviors (physical activity and dietary profile), blood collection and storage for biochemistry and future genetic analysis, electrocardiogram, and anthropometric measures. In addition, detailed information is being collected with respect to 4 environmental domains of interest-the built environment, nutrition and associated food policy, psychosocial/socioeconomic factors, and tobacco environment. A minimum follow-up of 10 years is currently planned. The PURE study has been recruiting since 2002 and by April 2009, had enrolled 139,506 individuals. The PURE study builds on the work and experience gained through conduct of the INTERHEART study. Its design and data collection are geared toward addressing major questions on causation and development of the underlying determinants of stroke in populations at varying stages of epidemiologic transition. (Teo et al 2009)

National programme on prevention and control of cardiovascular diseases, diabetes and stroke

Inaugurated in 2008 as a government of India initiative, this programme (now in its pilot phase) aims to address risk reduction and promote early diagnosis and appropriate management for prevention of diabetes, cardiovascular disease and stroke through health promotion for the general population and disease prevention for high-risk groups. Health promotion is targeted at the healthy, risk free population and involves development of an effective communication strategy to modify individual, group and community behaviour through media. It also focuses on community mobilization and participation and mainstreaming the health promotion. The interventions involve various settings in the community, school and work place. For disease prevention, the programme is focused on reducing morbidity and mortality by targeting people who suffer from elevated risks demonstrated through hypertension, obesity, high blood lipid and glucose levels and those who have suffered from a previous cerebral or coronary event and are at the high risk. To underpin these objectives, it is planned that the public health delivery system be strengthened at the primary, secondary level and tertiary level. (Ministry of Health 2008)

Indian Council of Medical Research: It has recently it has been announced that a National Stroke registry be established by the Indian Medical Research Council of India. (Sharma 2008) The pilot phase of this is currently underway in six centers. (Personal communications with Dr G Gururaj, National Institute of Mental Health & Neurosciences, Bangalore, India 26th October 2009)

Stroke policy in India

Stroke is a severely neglected condition in India. (Dalal et al 2007, Pandian 2007, Sethi et al 2007, O'Donnell + Yusuf 2009) Case fatality tends to be higher where there is little acute stroke care, and risk factors such as hypertension, for example, will be higher when only a small segment of the population is able to obtain antihypertensive medications. (Truelsen 2008) Both these conditions are currently present throughout India. There is a need to consider policies that address the risk for stroke in India with an emphasis on cost-effectiveness as well as its practice and management. For example it has been argued that the provision of secondary preventive measures are preferred and more cost effective than tPA in acute strokes in low- and middle-income countries. (Jeffrey 2009)

Despite widespread recognition for national stroke policy within India, (Bela + Marthur 2006, Biomedicine 2006, Hindu 2009) there is currently no national policy directed solely on stroke prevention, management or evaluation. Evidence suggests that policy and implementation for the prevention and control of chronic disease decreases the incidence of targeted diseases and has the potential to save many lives. (Kalita 2007) A national health promotion policy on for the prevention of risk factors on CHD and on stroke would need:

- Strategies on risk reduction of risk factors.
- Reductions in health inequalities.
- Promotion of health policy research to obtain regular and timely data on stroke related mortality and morbidity.
- Inter-sectoral cooperation of different ministries.

(Kalita 2007)

More specifically related to stroke, national policies should emphasise:

- Evidence-based training of community physicians and health workers in the prevention, diagnosis, management, and rehabilitation of stroke.
- Evidence-based public education about stroke warning symptoms, risk factors, morbidity, mortality, and importance of time window for acute treatment.
- Capacity building to provide sufficient resources for above education and delivery of stroke-related services

To date, the national government in India are responding with strengthening their stroke surveillance system and with the introduction of the National Programme on prevention and control of cardiovascular diseases, diabetes and. However, both remains yet in their infancy during the pilot phases. The passing of national anti-tobacco legislation in 2008, which bans smoking in public places throughout the country, (Government of India, 2008) is likely to have a positive impact on stroke prevalence and incidence rates.

It has been recommended that in order address the “neglected stroke epidemic” in India that national councils (health and finance) need to liaise with each other and related agencies such as the industry and the private sector so that the provision of stroke services can be better coordinated at all levels. (Sethi 2007, Dalal et al 2009) To underpin this, it is argued, there remains an urgent need for the Indian and state governments to enhance public awareness regarding stroke and preventative measures. (Banerjee et al 2005)

Gaps in stroke research and practice in India

Surveillance

According to the Asian Acute Stroke Advisory Panel, India is still ranked among the countries where information on stroke is presently minimal. (Banerjee and Das 2006) Not only are data sparse on incidence and prevalence of stroke but also on management and practice in the primary, secondary and tertiary levels. (Pandian et al 2007) Large international standardized registries are needed to understand the characteristics, presentation and management and outcomes after stroke as well as the regional variations in practice patterns, morbidity, and mortality. (O'Donnell + Yusuf 2009) These studies can clarify risk factors for stroke among different regions, ethnic group to monitor secular changes. This is based on the basis that large international cardiovascular studies have increased our understanding of incidence and risk factors for acute coronary syndromes (e.g. INTERHEART). Similar programmes are needed in stroke since the prevalence of cardiovascular risk factors measured at a national level are poor predictors of stroke mortality rates and burden. (Jeffrey 2009) Currently, there are several international and national research programmes in India that aiming to address this (INTERSTROKE, INSPIRE). Importantly, these initiatives are currently in their pilot phases.

It has been argued that there is an important difference in stroke epidemiology between developed and less developed countries: i.e. it has been shown that in developing countries there is a greater occurrence of haemorrhagic strokes, however this does not seem to concur with India. (Gupta et al 2008) Indeed, among the Parsi community in Mumbai, the proportion of ischaemic strokes was 96.5%. (Bharucha and Kuruvilla 1989) There may, therefore be some merit in exploring this further and as such more studies are needed to determine trends in stroke sub-types in India. This too may be addressed with the Indian Stroke Prospective Registry.

Guidelines and recommended practice

The introduction of guidelines and audit of clinical practice has been shown to improve clinical efficiency and effectiveness, enhance clinical decision making, support quality improvement programmes and improve quality of care for patients. (Woolf et al 1999) Guidelines on stroke prevention, management and evaluation are largely produced in the developed world and are often based on evidence undertaken in the developed world. (Internet Stroke Centre 2009) This is also true for the recently issued National Guidelines for the Management of Stroke in India (Indian Academy of Neurology 2010) developed in with an aim to close the gap between best and actual practice and in response at piecemeal quality improvement programmes. For example, in 2009, the Indian Association of Stroke in an attempt to ensure safe implementation of thrombolysis promoted its members to enroll on International SITS Register (Safe Implementation of Thrombolysis in Stroke). (Murthy 2009) As an international organization it aims to transfer the experiences from randomised controlled trials into clinical routine practice and allows clinical centres registered to follow their own treatment results and compare it with other centres world-wide. (SITS 2009) Although evidence of clinical management of stroke in India is minimal, attempts could be now be made in the routine collection of baseline data on in the prevention, treatment, management, provision of stroke facilities and evaluation of stroke either on a state or national basis and which could serve as a useful benchmark to identify gaps in provision and practice.

Primary and secondary prevention:

The influence of the appropriate use of evidence-based treatments on outcomes in patients with stroke is not known in India. (Gupta et al 2008) Implementation of mass screening surveys have been recommended to reduce the burden of stroke through the identification of people at high risk of stroke such as those with hypertension be undertaken to allow for simple and practical cost-effective measures and remedies to be prescribed. (Banarjee et al 2005) Whether this would be a useful tool needs to be further evaluated.

Patient knowledge and public awareness of stroke, its symptoms and risk factors is limited in India. (Panadian et al 2005) Cultural beliefs may influence treatment-seeking behavior among patients with stroke in India since it has been shown that people who practiced indigenous treatment (ayurvedic, homeopathic medicine etc) are less likely to be aware of the risk factors for stroke or identify symptoms of stroke. (Pandian et al 2005) Future, representative studies need to focus on different Indian communities, given the vast diversity within India. Lastly, efforts are urgently needed to educate the public about stroke symptoms, diagnosis, and treatment so optimize health care decisions and behaviors in order to help curb the growing stroke problem in India.

References

- Adams R et al. Update of the AHA/ASA recommendations for the prevention of stroke in patients with stroke and transient ischaemic attacks. *Stroke* 2008; 39: 1647-52
- American Stroke Association. Primary Prevention of Ischemic Stroke: A Guideline From the American Heart Association/American Stroke Association Stroke Council. *Stroke*. 2006;37:1583-1633
- Bhattacharya S, Prasarsaha S, Basu A, Das K. A 5 year prospective study of incidence, morbidity and mortality stroke profile on stroke in a rural community of Eastern India. *J Indian Med Assoc* 2005; 103 (12): 655-9
- Banarjee T, Roy M, Bhoi K. Is stroke increasing in India- preventative measures that need to be implemented. *J Indian Med Assoc* 2005; 103 (3): 162-6
- Banerjee T, Das S. Epidemiology of stroke in India. *Neurology Asia* 2006; 11: 1-4
- Bath P, Lees K. ABC of arterial and venous disease. Acute stroke *BMJ* 2000;320:920-923
- Bharucha N, Kuruvilla T. Epidemiology of stroke in India. *Neurol J Southeast Asia* 1998;3: 5-8
- Bharucha N, Bhraucha E, Bharucca A, Bhise A, Schoenberg B. Prevalence of stroke in the Parsi community of Bombay. *Stroke* 1988; 19: 60-2
- Bio-medicine. Neurologists call for a national stroke policy.6/23/2006. www.bio-medicine.org. Accessed October 2009
- Bonita R et al. The global stroke initiative. *Lancet Neuro* 2004; 3: 391-3
- The Canadian Cooperative Study Group. A randomized trial of aspirin and sulfinpyrazone in threatened stroke. *N Engl J Med* 1978;299(2):53-9.
- Cappuccio F, Oakeshott P, Strazzullo P, Kerry S. Application of Framingham risk estimates to ethnic minorities in United Kingdom and implications for primary prevention of heart disease in general practice: cross sectional population based study *BMJ* 2002; 325: 1271
- Central Bureau of Health Intelligence India. Mortality statistics in India 2006.-Status of mortality statistics reporting in India. A Report March 2007. Government of India.
- Dalal P, Bhattacharjee M, Vairale J, Bhat P. UN millennium development goals: can we halt the stroke epidemic in India? *Ann Indian AcadNeurol* 2007; 10: 130-6
- Dalal P et al. Population-bases stroke survey in Mumbai, India: Incidence and 28-day case fatality. *Neuroepidemiology* 2008; 31: 254-61
- Dalal P, Bhattacharjee, Vairale J, Bhat P. Mumbai stroke registry (2005-6)-Surveillance using WHO STEPS stroke instrument- challenges and opportunities. *JAPI* 2008; 56: 675-79

Das S et al. A prospective community based study of stroke in Kolkota, India. Stroke 2007; 38: 906-10

Das J, Hammer J. Money for nothing- the dire straights of medical practice in Dehi, India. A World Bank Policy Research Working Paper 3669; 2005

Das S, Banerjee T. Stroke Indian Scenario. Circulation 2008; 118: 2719-24

Ghamija R, Mittal S, Bansal B. Trends in Clinico-epidemiological correlates of stroke in the community. J Indian Acad Clin Med 2000; 5(1): 28-31

Government of India. Prohibition of smoking in public places rules 2008. Joint Secretary, Ministry of Health & Family Welfare, Government of India Press, New Delhi, India.

Gupta R, Joshi P, Mohan V, Reddy S, Yusuf S. Epidemiology and causation of coronary heart disease and stroke in India. Heart 2008; 94: 16-26

The Hindu. Evolve better treatment protocols for managing stroke, dementia. 30.Novemeber 2009. www.thehindu.com/2009/11/30/stories

Ezzati M, Lopez A, Rodgers A et al. Comparative quantification of health risks. Global and regional burden of disease attritutable to major risk factors. Geneva: WHO 2004

Feigin V, Lawes C, Bennet D, Barker_Cello S, Parag V. Worldwide stroke incidence and early case fatality in 56 population based studies: a systematic review. Lancet Neurology 2009; 8 (4): 355-369

Gosh J. Food for all. Frontline. 28th August 2009; pg 131-133

Indian Academy of Neurology and Indian Stroke Association. National guidelines for the management of stroke n India. Working Committee for Stroke guidelines 2010

Internet Stroke Centre: Guidelines and Consensus Statements. www.strokecentre.org/prof/guidelines. Accessed 4.11.2009

Internet Stroke Centre: Stroke Trial Registry. www.strokecentre.org/trials/intervention/. Accessed 17.11.2009

KalitaS. Need for a policy on chronic non communicable diseases in India. Working Paper for the Association for Physicians India 2007

Jeffrey S. Low-income countries bear biggest burden of stroke. Medscape Medical News.Feb 25, 2009

Joshi R. et al. Chronic disease now a leading cause of delath in rural India-mortality data from the Andhra Pradesh rural health initiative. Intern J of Epi 2006; 35: 1522-29

Leeder, S, Raymond S, Greenberg H. A Race Against Time: The challenge of cardiovascular disease in developing economies. 2004. Columbia University. New York City, New York.

Lipska K et al. Risk factors for acute ischaemic stroke in young adults in South India. J NeurolNeurosurg Psychiatry 2007; 78: 959-63

Lyons R, Rudd A, Alvaro C. Advances in health policy. Stroke 2008; 39: 264-7

Mackay J, Mensah G, Mendis S, Greenlund K. Atlas of heart disease and stroke. WHO 2004

Ministry of Health. Pilot phase of the National Programme for Prevention and Control of Diabetes, Cardiovascular Diseases and Stroke (NPDCS) .www.mohfw.nic.in. Accessed October 2009

Murthy J. Thrombolysis for stroke in India: Miles to go..... Neurology India 2007; 55 (1) 3-5

Nedeltchev K et al. Ischaemic stroke in young adults: predictors of outcome and recurrence. J Neurol Neurosurg Psychiatry 2005; 76: 191-5

O'Donnell M, Yusuf S. Lancet Neurology 2009; 8 (4): 306-7

Pandian J et al. Public awareness of warning symptoms, risk factors and treatment of stroke in Northwest India. Stroke 2005; 36: 644-48

Pandian J, Srikanth V, Read S, Thrift A. Poverty and stroke in India: a time to act. Stroke 2007; 38: 3063-9

Pandian J. Stroke in India: a silent epidemic. Ann Indian Acad Neurol 2008; S3

Prabhakaran D, Ajay V. Non-communicable Disease in India: A perspective. Centre for Chronic Disease Control discussion report for the WHO 2009, New Delhi, India.

Reddy S. Cardiovascular disease in non-western countries. NEJM 2004; 350: 24

St John's Research Institute 2008. The Division of Clinical Trials.www.sjri.res.in. Accessed October 2009

Sethi P. Stroke-incidence in India and management of ischaemic stroke. Neurosciences 2002; 4 (3): 139-141

Sethi P, Anand I, Ranjan R, Sethi N, Torgovnick J. Stroke: the neglected epidemic: an Indian perspective. Internet J of Neur 2007; 8 (1): 1-8

Shah B. Development of sentinel health monitoring centers for surveillance of risk factors for non-communicable disease in India. Report from the Division of Non-communicable Diseases, Indian Council of Medical Research, New Delhi 2005

Shah B, Mathur P. Workshop Report on Stroke Surveillance in India. Division of Non-communicable Diseases, Indian Council of Medical Research, New Delhi 2006

Sharma S. City to participate in national stroke registry. Express India 24.5.2008.

SITS- Safe implementation of thrombolysis in stroke. www.acutestroke.org/SITS/ accessed 18th November 2009

Sridharan S et al. Incidence, types, risk factors and outcome of stroke in a developing country: the Trivandrum Stroke Registry. Stroke 2009; 40: 1212-18

Srivatava A, Prasad K. A study of factors delaying hospital arrival of patients with acute stroke. *Neurology India* 2001; 49: 272-6

Strazzullo P, D'Elia L, Kandala N, Cappucio F. Salt intake, stroke and cardiovascular disease- meta-analysis of prospective studies. *BMJ*; 339: b4567

Teo K, Chow CK, Vaz M, Rangarajan S, Yusuf S. Prospective Urban Rural Epidemiology (PURE) study: examining the impact of societal influences on chronic non-communicable diseases in low, middle-, and high-income countries. *Am Heart J.* 2009;158(1):1-7.e1.

Tripathy A, Jeemon P, Ajay V, Prabhakaran D, Reddy K. CVD profile of India. *IC Health and WHO* 2007; APW SE/06/226543

Truelsen T, Bonita R, Jamrozik K. Surveillance of stroke: a global perspective. *Intern J Epi* 2001; 30: S11-16

Truelsen T. Experience from the Mumbai Stroke Register. *Neuroepidemiology* 2008; 31: 262-3

The Stroke Association UK. What is A Stroke. 2008.www.stroke.org.uk, Accessed 7th October 2009

Woolf S, Grol R, Hutchinson A, Eccles M, Grimshaw J. Potential benefits, limitations, and harms of clinical guidelines. *BMJ* 1999; 318:527-530

World Health Organisation. Comparative quantification of health risks. Global and regional burden of disease attributable to major risk factors. Geneva: World Health Organisation, 2004.

World Health Organisation .Disease and injury regional estimates for 2004. Geneva, Switzerland. Available at: http://www.who.int/healthinfo/global_burden_disease/estimates_regional/en/index.html. Accessed 14 October 2009.

World Health Organisation. Preventing Chronic Diseases: A vital investment. Geneva, Switzerland. 2005.

World Health Organisation. Stroke. www.whoindia.org/SCN/ASSBOD/05-stroke. Accessed 6th October 2009

World Health Organisation. STEPS Stroke Manual. www.who.int/chp/steps/stroke. Accessed 23rd October 2009

World Health Organisation. The Atlas of Heart Disease and Stroke. Geneva, Switzerland. Available at: http://www.who.int/cardiovascular_diseases/resources/atlas/en/index.html. Accessed 5th September 2009

World Health Organisation. Measurement in health. Statistics Tables 2009

Zodpey S, Tiwari R, Kulkarni H. Risk factors for haemorrhagic stroke: a case-control study. *Public Health* 2000; 114: 177-82

