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Genesis and Progress in Concepts of Preventive Cardiology: A Historical Overview

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Abstract

Diseases of the heart and vascular system, although known since antiquity, are basically a malady of modern times. The understanding of structure and function of the heart reveal that the diseases affecting this system, referred to as cardiovascular diseases (CVD), are varied and have multifactorial aetiology. Since the last decade, CVD emerged as the leading cause of death worldwide which can be associated with the force of globalization. Rampant increase in industrialization, urbanization, unhealthy diet, sedentary life style, obesity and tobacco addiction resulted in the epidemic of heart diseases. Consequently the burden on national health care machinery has increased considerably. Although treatment facilities have improved immensely, it is still inadequate and over expensive. As a result it is becoming difficult to control the premature death and debility due to CVD. Epidemiological studies and risk factor assessment of CVD have provided evidence based support for the feasibility of implementing preventive strategies for this group of diseases in recent times, which were earlier considered only for communicable diseases. In the present study an attempt has been made to trace the genesis of the concept of CVD prevention and follow its development to a new branch of medicine termed "Preventive Cardiology" which specifically concentrates on protection and maintenance of health of the heart and vascular system.

Key words: Cardiovascular diseases, *Caraka Saṃhitā,* DASH Study, Framingham study, *Hṛdroga,* INTERHEART Study, INTERSALT Study, Preventive cardiology, *Suśruta Saṃhitā.*

1. Introduction

Advances in medicine and medical practices cannot be well appreciated without a proper knowledge of the history of its evolution which, apart from natural sciences, is also influenced by philosophy, religion, natural calamities, war and socio-cultural transition over time. India is a land of rich cultural heritage and the classical Indian art of healing was a highly developed science which had spread far and wide and influenced other ancient medical systems as well until the Europeans established their influence in all fields and introduced their approach to medicine as being superior and modern.

Cardiovascular diseases (CVD) in modern medicine refer to a class of diseased condition involving the heart and vascular system (arteries and veins) viz. cardiac disease, vascular diseases of the brain, kidney and peripheral arteries. Blockage of blood vessels in the heart may constrict the flow of blood through the body leading to a serious condition which, if left untreated, may be fatal. Types of CVD include coronary heart disease (ischaemic heart disease, coronary artery disease), cardiomyopathy (disease of heart muscles), hypertensive heart disease, heart failure, cardiac dysrhythmias (abnormal heart beat), inflammatory heart disease, vascular heart disease, cerebrovascular disease (disorder of the

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blood supply in brain) and peripheral arterial disease.

Currently CVD are the most prevalent cause of death and disability worldwide. A phase of epidemiological transition from communicable to non-communicable diseases, particularly CVD, is also evident in India since late 19th century and this has lately emerged as one of the leading cause of untimely death in our country. The World Health Organization, for quite some time now, has been sounding an alarm to the rising burden of CVD on human society. As in case of diabetes, the rapid rise in prevalence rate of CVD over a period of few decades has been found to be associated with rise in prevalence of risk factors like hypertension and changed life style. CVD is also related to diabetes and diabetics are at a higher risk for developing heart related disorders. Cardiovascular manifestation as complications following HIV and AIDS infections, cancer and several other diseases are also on record making CVD as a factor for the major mortalities in today's world. Over the years several lines of treatment have evolved, comprising of medical and surgical practices, for management of CVD because it includes a wide variety of disorders of the heart and the vascular system. However over the years it became increasingly apparent that treatment alone is not enough to control this group of life threatening and debilitating disease. This provided the impetus for recognising the importance of preventive intervention.

Jeremiah Stamler is one of the pioneers in Preventive Cardiology who started his research on heart diseases as early as 1947 and studied the role of nutrients and salts in the aetiology of hypertension and coronary heart diseases. He is credited with the introduction of the term "risk factors" in connection with CVD. His laboratory studies on animal convinced him of the role of salt and cholesterol as causative agents for atherosclerotic vascular disease. His population based cohort studies undertaken during the 1950s defined the role of health behaviours and associated measurable biologic traits with respect to the CVD epidemic of the Unite States at that time. A comprehensive report on the progress of preventive cardiology in the 20th century was presented by Pyorala at the 2nd International Conference on Preventive Cardiology held at Washington DC in 1989 (Pyorala, 1990). Although understanding of the structure and function of the heart and treatment and prevention of the related diseases seems to be feat of modern medicine, *hṛdroga* (heart diseases) and *hṛdyota* (functional disorders of the heart) finds mention in *Atharvaveda* (Roychowdhury, 1988). The first attempt to discuss circulation in tubular structures were made in *Atharvaveda* (*Atharva Veda* X.2.11) almost 2500 years before William Harvey described it in his book "*De Motu Cordis et Sanguinis in Animali*" in 1628. According to the later Vedic Āryans human body had 100 *dhamanīs* (major blood vessels), 100 *hiras* (minor vessels) (*Atharva Veda* I.17.1, VI.90.2) and 72000 *hiras* (capillaries) (Srh.Up ii.1.19). *Caraka Saṃhitā* and *Suśruta Saṃhitā* also mention heart disease as *hṛdroga* and there are detailed descriptions of the signs and symptoms for its diagnosis, treatment and prevention. *Hṛdaya* (heart) is listed in *Caraka Saṃhitā* as one of the three most vital organs (*marmas*) of the body the other two being *sira* (head) and *basti* (kidney and bladder) (*CS. Sa*. 7.9). Mention of 10 great vessels rooted in the heart (*CS. Sū*. 30.3-4) may be considered significant. From the heart as root, the 10 great vessels were considered to carry *ojas* (nourishing fluid) throughout the body by pulsating **(***CS. Sū*. 30.8**)**. The *ojas* maintains the living being and is the essence of nourishing material which enters the cardiac cycle first (*CS. Sū*. 30. 9-11). Mention are found of *dhamanis* (arteries) and *siras* (veins) and *srotas* (flow, channel) in connection with the description and function of the heart (*CS. Sū*. 30. 12). Excessive physical exercise, purgation, anxiety, fear and family management disorders are among the causative factors of heart disease

mentioned **(***CS. Cī.* 26. 70-73**).** Measures for prevention of heart disorders recommended were avoidance of the major causes of this diseases through leading a life of health, strength and happiness promoting paths and knowledge (*CS. Sū*. 30. 13-15). Dietary advice and treatment for heart diseases, according to type and relative degree of the ailment, were described in *Caraka Saṃhitā* (*CS. Ci*. 26. 74-79).

Suśruta Saṃhitā describes heart as a lotus bud pointed downwards (*SS. Sa*. 4. 32) and mentions locations of *dhamanis* (blood vessels) (*SS. Sā.* 6. 4-5) within which flows a watery red coloured fluid called *rakta* (blood) and mentions that the colour is attained in liver and spleen **(***SS. Sū*. 14. 4-5,16-17**)**. The aggravation of *doṣas* by suppression of urges, intake of excessive hot and rough food, indigestion, trauma as well as micro-organisms were considered as the causes of *hṛdroga* (*SS. Utta*. 43. 5-9). Management for different types of heart diseases have also been enumerated (*SS. Utta*. 43. 10-22). *Mādhava Nidāna* of Mādhavakara (c 8th century AD) provides a comprehensive description of diseases, mainly based on *Caraka Saṃhitā, Suśruta Saṃhitā, Aṣṭānga Saṃgraha* and*, Aṣṭānga Hṛdaya* where five kinds of heart diseases are described (*Mā.Ni*. 29.1-7). Causes mentioned for these diseases include unhealthy food, excessive worry, physical over activity, injury and suppression of urges of the body.

All these descriptions do indicate quite a good knowledge of the anatomy of the heart, blood circulation, the associated diseases and medical practices for their prevention and treatment in India from a remote past. Perhaps the Āyurvedic practices protected the Indians for generations from many of the lifestyle disease including CVD until it started to surface towards the end of the 19th century. Such records in ancient Indian medical texts were overlooked and ignored for long and the trend was to suggest that all knowledge of human anatomy and advent of medical practices developed in Europe. The credit of first describing blood circulation therefore goes to William Harvey, the English physician, in 1628 (Ribatti, 2009) and description of the structures of heart's chambers and vessels to Raymond de Vieussens, a French Anatomy professor, in 1706 (Loukas et al., 2007). Stephen Hales, an English clergyman and scientist was the first to measure blood pressure in 1733 (Lewis, 1994). The first modern description of heart disease resulting from hardening of arteries came from James B. Herrick, an American physician in 1912 (James, 2000).

2. Assessment of Risk Factors for Heart Diseases

Risk assessment is a key component as well as a prerequisite on which modern concepts and guidelines for prevention of diseases have developed. Moreover a data base for identification of high risk individuals or groups can be prepared which can provide a platform from which primary preventive programmes, targeted at asymptomatic subjects, can be launched.

It appears that although the disease was known since ancient times, it was of rare occurrence. Before 1900, very few people died of CVD, but the scenario changed sharply between 1940-67. This attracted attention of the World Health Organisation to proclaim heart diseases as the most serious global epidemic. That was a turning point in medical history when research was focussed on a search for the causes and cures of this group of diseases. Among the several reasons that were accounted for this trend is increase in average life expectancy, rising levels of obesity and reduced physical activity. Before the industrial revolution, manual labour was involved in daily life, walking was the main means of transportation, laundry was a physical effort, stairs were climbed, carpets were beaten and floor and household cleaning was done involving physical labour until the arrival of automation to make life easy. The combination of sedentary life and unhealthy food

led to an increase in clogged blood vessels, heart attacks and strokes.

Risk factor assessment for CVD done systematically through large multinational studies is a seemingly new area of medical research. There are ample evidences cited in literature to demonstrate a causal linkage between various physiological factors, mostly arising out of life style changes, and CVD. However further clinical assessments form a part of the ongoing endeavour in this area for a better understanding of the diseases. Behaviour modification and stress management interventions have produced favourable outcome in prevention studies for CVD, which forms the basis of development of concepts and strategies for prevention of this group of diseases.

One of the landmarks and much referred study in this line is that of Framingham (Dawber et al., 1950; Kannel, 1976, pp. 269-282). Framingham Heart Study was taken up under the direction of the National Heart Institute (now known as the National Heart, Lung, and Blood Institute or NHLBI) as a joint project with the Boston University, at a time when death rates for CVD had been increasing steadily but little was known about the general causes of heart disease and stroke. The objective of this study was to identify the common factors or characteristics that contribute to CVD by following its development over a long period of time in a large group of participants who had not yet developed overt symptoms of CVD or suffered a heart attack or stroke. The first round of extensive physical examinations and lifestyle interviews was conducted on 5,209 men and women in the age group of 30-62 recruited from the town of Framingham, Massachusetts. In 1971, the Study enrolled a second generation which consisted of 5,124 of the original participants' adult children and their spouses. The need for a new study reflecting a more diverse community of Framingham was recognized in 1994, and the first Omni cohort of the Framingham Heart Study was enrolled. The study was continued further which entered a new phase in April 2002 when of a third generation of participants, the grandchildren of the Original Cohort were enrolled, and in 2003, a second group of Omni participants was enrolled. This study clarified the importance of life style related risk factors and was in fact the first to attempt identification of "risk factors" for heart diseases and relate the influence of life style, environmental and hereditary factors with this group of diseases.

In this connection mention may be made of the INTERHEART Case Control Study (2004, pp. 937-952) conducted on 27000 subjects in over 52 countries to evaluate the risk factors for the first attack of myocardial infarction (INTERHEART, 2004, pp. 937-952). The aim of this global study was to determine the associations between a wide range of risk factors within populations defined by ethnicity and/or geographic region, and to assess the relative importance of these risk factors across these populations. This study had helped to clarify the role of life style risk factors in the Indian context also. It is now well recognised that both behavioural risk factors (tobacco habit, physical inactivity and dietary factors) and the biological risk factors (blood pressure, dyslipidemia and diabetes) are equally important. Many other studies on this aspect suggested the role of different risk factors in the causation of CVD from which reports 9 risk factors were considered to be particularly associated with heart disorders. They are High Blood Pressure, High LDL (Low Density Lipoprotein), High Cholesterol, Platelet Aggregation, Diabetes, Dyslipidemia, Tobacco Use, Physical Inactivity and Unhealthy Diet. The risk factor approach for risk factor reduction / modification as a preventive concept for CVD was an outcome of these studies.

The pathogenesis of acute coronary syndrome in CVD was found to be associated with a process known as atherosclerosis which leads to the formation of plaques and narrowing in the lumen of coronary artery. The term is derived from the Greek word *athere* meaning "gruel" and *sclerosis* meaning "hard". This describes the mature atherosclerotic plaques formed in blood vessels. It may be of interest to note that although generally thought to be a disease of modern times, evidence for its existence is found from CT scan of some 3500 years old Egyptian mummies (Maugh, 2009). The atherosclerotic plaques were found to be formed as an insidious and chronic fibro-inflammatory process, associated with several bacterial and viral agents (Ross, 1999, pp. 115-126), which passes through different morphological stages. The bacteria *Helicobacter pylori* and *Chlamydia pneumonia*e were shown to contribute to the progression of atherosclerosis. Certain adenovirus, enterovirus, cytomegalovirus and herpes simplex virus are also suspected to be associated with atherosclerosis and consequently heart disorders (Roivainen *et al*., 2000, pp.252-57). It appears that existence of two types of atherosclerotic lesions was known since long (about 150years) as a fatty deposit and as a fibrotic streak. However there was a controversy regarding whether both types of lesions were expression of the same pathological condition or not (Starry *et al*, 1995; Faxon *et al*, 2004). Ludwig Aschoff, (1866-1942) a German physician and pathologist of the early 20th century was the first to recognize the two lesions as different stage of the same disease; he considered the fatty form to be the early stage and the fibrotic form added to the fatty component as the mature stage of atherosclerosis. Pathological description of atherosclerosis in 1950s confirmed this condition to be a progressive disease involving development of fatty streak followed by the fibrotic plaque which leads to formation of the complicated lesion of atherosclerosis (Gore and Teja, 1957). The American Heart Association classified atherosclerotic lesions into six types based on the histological morphology of lesions and correlated their composition with the clinical manifestation of the disease. The early type I and II lesions occur in infants and children, type III is noted soon after puberty and the advanced lesions evolve after the age of about 30 years. The early lesions are silent but they manifest clinically in later stages as reduced blood flow and insufficient delivery of oxygen and nutrients to different parts of the body including the heart (Schoen, 2005). Anitschkow (1885-1965), a prominent Russian pathologist, first demonstrated the association between cholesterol and atherosclerosis experimentally in 1912; later it was shown that the mean serum total cholesterol correlated with the severity of the disease (Roberts, 1995). The Bogalusa Heart Study revealed a positive correlation in humans between the severity of the atherosclerotic plaque in the aorta with the percent of dietary calories from fat (Newman *et al.*, 1986). Among total cholesterol, LDL and HDL, high LDL cholesterol was found to be the primary lipid risk factor associated with atherosclerosis (Babiak & Rudel, 1987).

Atherosclerosis and coronary heart diseases were rare in India up to the early twentieth century. Around mid 1900, India provided a fertile ground for researches in epidemiology of CVD, as the country offered a great variety in ethnic and socio-economic groups with different life style patterns and food habits. Studies from four Indian cities, New Delhi, Agra, Coonoor and Trivandrum, suggested that the majority of people in India in the low income group had a diet of low fat while those better economically consumed higher fat calories; the serum cholesterol levels were significantly higher in the rich than in the poor which could be correlated with the percentage of calories from fat (Gopalan and Ramanathan, 1958, Padmavati *et al.*, 1959, Mathur *et al.,* 1959). A review was made by Padmavati (1962) on the prevalence of coronary artery disease in India,

assessed in different states. Available autopsy, clinical observation, epidemiological studies and life insurance data revealed that in Indian men degree of atherosclerosis was much lower than in American men, while the same in women from these two countries were similar. The peak period of the disease was the sixth decade in Indian men and seventh decade in Indian women. The study suggested that during mid nineties the prevalence of coronary artery disease in India was comparatively low and incidence of the disease was higher in the high-income group as compared to the low-income group. Interestingly it was also pointed out that prevalence rate among low-income group in India was much lower than the same group in other countries while in case of the high-income group from India the prevalence was higher. The high risk factors among affluent classes were considered to be longer life expectancy along with richer diet, high fat intake and high serum cholesterol level. Following the pioneering reviews, several important studies were undertaken to assess the risk factors of CVD in India (Singh *et al.*, 1997, 1998, 1999; Shani and Ranga, 2000; Reddy, 2000; Mohan and Deepa 2004).

Among the many risk factors, hypertension and diabetes have a significant etiological role in the occurrence of CVD (Abbott *et al.*, 1988, Anderson *et al.*, 1991, UK Prospective Diabetes Study Group, 1998, Lewington *et al.*, 2002, Yusuf 2004). Both of these risk factors are profoundly influenced by diet and obesity. This has been an area of much research activities. Diet is a mixture of varied components of food and nutrients which interact with one another to influence body metabolism Moreover dietary risk factors contribute differently to disorders under different environmental and ethnic settings. Although some specific nutrients are well established as dietary risk for CVD, overall dietary patterns have a more crucial role to play in this respect (Getz and Reardon, 2007). Comparison between a diet low in saturated fats with plenty of fresh fruits and vegetables and the high calorie diet rich in saturated and transfats, typical of the developed world, has shown that risk for cardiac events in the former dietary pattern is about 73% lower than that from of the latter (World Heart Federation, 2013). The difference is attributed to the fact that abnormal lipid (fat) levels have a strong correlation with coronary artery disease, heart attack and coronary death. Saturated and trans-saturated fats (used in bakeries and in fast foods) contribute largely to the high blood cholesterol levels which are implicated in atherosclerosis. It is of interest to note that diet-lipid-heart disease hypothesis was proposed by Ancel Keys in 1957. This was based on his observation that dietary saturated fat and cholesterol raise blood cholesterol in humans (Keys, 1965) thereby increasing the risk of heart diseases. This hypothesis was accepted without much challenge by health authorities for about half a century, until further research in later years raised question on Keys hypothesis. Reiser (1973) had published a critical review on this subject. Gary Taubs, the American science journalist had initiated many scientific controversies and came into prominence during 2002 for his debate on low-carb diet and health benefits of low fat diet, which helped shape the line of thinking related to dietary influence on heart diseases. The observation and relationship on dietary lipids and cholesterol in coronary heart disease has been presented in great detail by Okuyama *et al* (2007, 2014). Recent studies question the earlier guidelines that encourage high consumption of poly unsaturated fatty acids and low consumption of total saturated fats for prevention of CVD.

Epidemiologic findings suggest that eating fruits and vegetables lowers blood pressure. It was noted from the DASH (dietary approach to stop hypertension) study that population*s* eating mainly vegetarian diets have lower blood pressure levels than those eating omnivorous diets. Two

hypotheses were tested in this study viz that high intake of fruits and vegetables lowers blood pressure, and that an overall dietary pattern (high in fruits, vegetables, nuts, low-fat dairy products, fish and chicken rather than red meat, and is low in saturated fat, cholesterol, sugar, and refined carbohydrate) lowers blood pressure. The result of DASH study suggested that diet may offer an alternative to drug therapy in hypertensive subjects and as a population approach, may prevent hypertension, particularly in African Americans (Sacks *et al.,* 1999, Colin *et al.*, 2000).

The risk of hypertension is also considered to be increased by higher intake of salt (sodium) from fast food. The INTERSALT study based on observation of samples from 52 centres in 32 countries had revealed a significant association between dietary salt, measured by 24 hour urine sodium excretion, and systolic blood pressure (Intersalt Cooperative Research Group,1988, Stamler *et al.,* 1989). Data from this study permit an estimate of the effect of lower sodium intake on average population blood pressure. This study was however severely criticised by the science writer Gary Taubes in 1997 for failure to account for population heterogeneity in establishing the weak association between salt intake and blood pressure. Freedman and Pettiti (2008) also raised questions about why the researchers had failed to apply even basic robustness checks, and criticised the overly simplistic view presented by medical researchers and policymakers of the role of salt in blood pressure outcomes. In view of the contradictions in the hypothesis due to experimental evidence suggesting that the effect of a large reduction in salt intake on blood pressure is modest, health consequences of high intake of salt in reference to CVD remain to be conclusively determined.

Over indulgence in protein and carbohydrate in daily diet is associated with the aetiology of diabetes – another risk factor for CVD (De Fronzo, 1991). Strong association between total cholesterol (TC), low density lipoprotein cholesterol (LDL-C) and risk of heart disease has been clarified through several studies (Kannel *et al.*, 1971, Kannel, 1985). Obesity, an outcome of faulty dietary habit, as a risk for several diseases including CVD is reported (Must *et al.,* 1999, Napier, 2006). Insights into gender-specific aspects of CVD risk revealed that high level of serum cholesterol was a risk for both men and women (Greenland *et al.*, 1998). But in contrast to men, in women the lipid and lipoprotein levels vary according to their ovarian function. Consequently women's risk for CVD depend to a large extent on changes in ovarian function (Kannel, 2002; Foody 2006).

Tobacco use in the form of cigarettes, which reached its fashionable peak around 1950s, has been identified as a major risk factor for coronary heart disease. The high mortality from CVD among tobacco smokers, which had become the "most over-practiced addiction" of the world (De Nelsky, 1998), was attributed specifically to tobacco (Peto *et al.* 1996). It was sometime in 1964 that Surgeon General and his advisory committee reviewed 7000 scientific articles and released their report entitled "Smoking and Health" condemning the use of tobacco indicating its adverse effect on health (Terry, 1983). Subsequent reports revealed the association of tobacco use with several health hazards including the risk factor for CVD (Buchsbaum and Buchsbaum, 2006). Cigarette smoking is the most important modifiable risk factor for the early events of endothelial damage and dysfunction associated with atherosclerosis. Research finding linking smoking and CVD moved on to show that tobacco smoke added to environmental pollution and passive smoking were risk factors for non-smokers too. Further epidemiological studies revealed that other chemicals in the environment like ozone, carbon monoxide, sulphur dioxide, nitrogen oxides, metal pollutants viz. arsenic and mercury, could be linked to CVD as well as pulmonary diseases and

cancer (Bhatnagar, 2006). Out of the many toxic chemicals present in tobacco smoke, nicotine and carbon monoxide were shown to be the most hazardous ingredients which adversely affect the cardiovascular system (Johnstone and Plimmer, 1959).

Tobacco smoke impairs the oxygen carrying capacity of haemoglobin (Adams *et al*, 1988) and result in vasoconstriction, platelet adhesion and hypercoagulability, catecholamine release and endothelial dysfunction (Benowitz and Gourlay, 1997). Smoking a single cigarette is enough to increased heart beat, myocardial oxygen demand, peripheral resistance and cardiac output (Thomas and Murphy, 1960; Lekakis *et al.* 1998,). Furthermore, chronic smoking is known to induce plaque formation by lowering fibrinolytic function (Allen *et al* 1885), to be associated with increased serum cholesterol, reduced high density lipoproteins and to damage blood vessel walls (Allen *et al*, 1985). Passive smoking is also a causal factor for heart diseases in adults, children and even newborns, working through a similar mechanism of action (Nelson, 2001).

Various forms of smokeless tobacco (ST) products (snuff, chewing tobacco) are used by individuals of all ages. This practice is quite rampant in our country and is a cause of great concern as a health hazard. There is scientific evidence regarding ST product use and the potential cardiovascular risks, though the evidence suggests that the cardiovascular risks are lower with ST products compared with cigarette smoking (Mariann R. Piano *et al*, 2010). This information has been important for policy matters related to tobacco control and development of strategies for tobacco harm reduction. It has reported that long-term ST product use may be associated with a modest risk of fatal myocardial infarction (MI) and fatal stroke, suggesting that ST product use may complicate or reduce the chance for survival after a MI or stroke. Such observations support the need to discourage use of all tobacco products and emphasize prevention of smoking initiation and smoking cessation as primary goals for tobacco control (Hatsukami *et al*, 2007)

The CVD risk from tobacco use is more prevalent in the economically backward section of the society in India (Reddy *et al,* 2007). Attention has also been drawn to the risk from other environmental pollutants (Pamani, 2009). Lately, CVD have reached epidemic proportions in our country too. A recently conducted INTERHEART study has emphasized the role of behavioural and conventional risk factors, which are potentially modifiable (Ajay and Prabhakaran, 2010). This international case-control study has listed nine confirmed risk factors for CVD (which is alarmingly on the increase worldwide including India) as abnormal lipids, smoking, hypertension, diabetes, abdominal obesity, psychological stress, alcohol, decreased consumption of fruits and vegetables and lack of physical activity (INTERHEART study Investigators, 2004, pp. 937-952) . This study, highlighting the potentially modifiable risk factors, has provided a strong impetus for considering the feasibility of low cost preventive strategies to address the growing public health concern for this chronic life threatening human malady.

Aristotle had asserted that heart was the seat of emotions; although this idea was not essentially correct, there are now ample evidences to point towards an association between the heart and brain which is now well established as the seat of all matters of the consciousness. Significant role of mental stress arising out of psychological, psychosocial and emotional distress on pathogenesis of CVD is reported (Trigo *et al*, 2005; Graeber *et al*, 2006) to show that the heart response may be affected by emotional factors. There are instances of sudden death due to mental stress arising out of anxiety and anger, indicating that mental stress is indeed a risk factor for development of CVD and sudden heart attack. It

has been found that both acute and chronic stress have adverse effect on the heart. While acute stress can precipitate catastrophic effects, persistent stress over a period can damage the cardiovascular system function creating a predisposing situation for acute cardiovascular event (Mittleman *et al*, 1995; Leor *et al*, 1996; Rozanski *et al*, 1999). Multiple studies have established that occurrence and progression of CVD is associated with depression (Glassman and Shapiro, 1998; Rozanski *et al* 1999). Research in physiology and pathophysiology of the brain and heart in connection with stress revealed the existence of a complex but integrated interrelationship between centres dealing with emotion and response of heart. Links noted between the central nervous system and the heart were explained in terms of autonomic interactions (Phan *et al*, 2003; Soufer *et al*, 1998; Damasio *et al* 2000; Critchley *et al* 2000; Tillfors *et al*, 2001). Extensive literature is available to provide ample evidences for a causal link between psychosocial factors and CVD. The risk from these factors is comparable to other major risks and may add to them thereby increasing CVD incidence by many fold (Theorell. 1992).

3. Concepts and Strategies for Prevention of CVD

Risk Factor Assessment results inevitably stimulated the conceptualization of preventive intervention for CVD at different phases. Geoffrey Rose, the eminent epidemiologist is to be credited with the concept of prevention of diseases targeting vulnerable individuals. He raised the importance of questioning "why some individuals have hypertension" and "why do some population have much hypertension whilst in others it is rare" and proposed the "high risk approach" to protect susceptible individuals by providing available medical resources and "population approach" seeking to control the causes of incidence (Rose, 1985). The concept of prevention based on risk factors for CVD envisage appropriate and adequate control of modifiable environmental and biological risks, wherever feasible, and by early detection, medical intervention and advocacy on life style modification. Genetic predisposition as well as gender related risks have been emphasized while considering preventive measures. Several lines of contemplation provided the guidelines for developing multi-faceted concepts and multi-disciplinary approaches, giving rise to a specialized branch of medicine viz. Preventive Cardiology.

Prevention of progression as well as regression of the different patho-physiological conditions which result in expression of CVD, are areas focussed during developing preventive strategies. The field of cardiology has witnessed a gradual transition from solely treatment oriented perspective of the last several years to a new prevention-based perspective especially considering the modifiable risk factors. Multiple risk factors which are additive or synergistic have become apparent (Kennel and Wilson 1995). Obviously, the importance of maintaining cardiovascular health of a population in general is gaining ground as a public health effort considering the fact that CVD is multifactorial in origin.

As early as 1912, Anitschkov first reported a connection between cholesterol and atherosclerotic plaques in rabbits fed high fatty diet which was confirmed later through human studies from 14 countries (Roberts, 1995, pp.580-600). That increased levels of low density lipoprotein (LDL) initiate and sustain atherosclerosis were shown in experimental animals (Goldstein *et al,* 1983, pp. 288-296) and humans (Babiak and Rudel, 1987, pp.515-550). Since atherosclerosis forms one of the important risks for CVD, primordial prevention of this condition was considered appropriate for maintenance of cardiac health. Multiple diagnostic tests for detecting subclinical atherosclerosis have

been considered for prevention or restriction of progress of atherosclerosis. This approach may have a role in individual cases but is not recommended or considered viable for a population (Shah and Foody, 2006). Use of aspirin, which can decrease lesions of atherosclerosis, a chronic progressive fibro-inflammatory disease (Kouraklis *et al* 2004), was suggested as a risk reducing approach for preventing CVD in males (Steering Committee of Physicians' Report, 1989). A British Study Group however failed to observe any significant benefit from aspirin use (Peto *et al*,1988). The Preventive Services Task Force and the American Heart Association provided a guideline in 2002 for primary prevention of CVD which recommended aspirin for adults with high risk (Pearson, Blair, David, 2002). In 2004 recommendations for aspirin therapy was made by American Diabetes Association for primary prevention in diabetic men and women above the age of 40 years with high CVR risk from family history, hypertension, smoking, dyslipidemia or albuminuria (Colwell 2004). However this preventive therapy was not to be given to younger people below 21 years, as the effect of aspirin was not studied in this group. Another study conducted on healthy women in the age group of 45 or higher revealed that a regular use of low dose aspirin had a significant risk reduction for stroke, ischemic stroke and transient ischemic attack, but there was no effect on myocardial infarction and cardiovascular mortality (Ridker *et al* 2005). Two British researchers Wald and Law (2003) did put forward a "Polypill concept" for primary prevention of CVD by using a combination of six drugs which originally contained a statin, three antihypertensive agents, aspirin and folic acid as a public health approach. Many concerns were expressed by experts on this issue and the concept was considered debatable. In the absence of CVD outcome data with Polypill for primary prevention, this was considered to be useful for secondary prevention of CVD for now in patients with established disease.

Hypertension may be defined as a condition where blood pressure measurement exceeds 140/90 Hg in absence of diabetes or renal insufficiency and that which exceeds 130/80 in diabetics or kidney disorder under anti-hypertensive drugs. Evidence from population studies on hypertension has shown it to be a risk factor for stroke, heart failure and myocardial infarction (Lewington *et al* 2002,). With the understanding of the consequences of elevated blood pressure from these and other studies, conceptualization of yet another approach towards prevention of CVD emerged as Hypertension management strategy since early 21st century (Chobian *et al* 2003) which can be achieved by use of medication or technology based timely intervention. Antihypertensive treatment with Thiazide diuretics were introduced as early as 1957 but only for cases of life-threatening levels of blood pressure. Later use of fixed dose combinations of this anti-hypertensive agent with drugs like peripheral sympathetic blocker and vasodialator demonstrated their efficacy and tolerability giving rise to better medication for hypertensive patients with a lower risk for complications (Veterans Adm. Coop. Study Gr. 1967,1970, Moser 1997). The results from the pilot and main trials of Systolic Hypertension in the Elderly Programme (1984,1991) demonstrated that active treatment with thiazide-like agent with ā-adrenergic blocker provided a 32% risk reduction in morbidity and mortality from all CVD (Hulley *et al* 1984, SHEP 1991). These studies were based on earlier observations from trials conducted during 1970-79 showing risk reduction for CVD by treatment for hypertension.

Since psycho-sociological conditions have a profound impact on CVD risk, attempt to assess and address these issues is one approach for CVD prevention. Behaviour modification and management of stress related symptoms as components of cardiac health and rehabilitation are often recommended. Identification of existing

psychosocial problems which generate stress and timely intervention for resolving them is also suggested as a method for maintenance of cardiac health (Frasure-Smith *et al* 1993; Albus *et al*. 2004).

The risk of CVD is significantly increased by presence of chronic kidney disease (CKD); therefore another approach for prevention of CVD is to "protect the kidneys for saving the heart" particularly in diabetics and in hypertension. Use of biomarkers for detection of CKD, which are now readily available and relatively inexpensive, serve to detect and treat CKD at an early stage and afford cardio-protection as a measure for CVD prevention (Raju, 2012).

The most important sequel of Rheumatic fever, caused by streptococcal infection in children is Rheumatoid heart disease (RHD). This may cause significant morbidity and mortality due to CVD later in life. As a means of protection of RHD, early diagnosis and treatment of rheumatic fever assumes significance (Khanna, 2012).

Dietary approaches for reducing CVD risk from fat components, obesity, hypertension and tobacco have received much attention in recent times especially with respect to the clinically symptom free subjects. Trends in high calorie intake from fatty fast food and refined carbohydrates, elevated uptake of sodium from processed food and condiment, tobacco habit in any form, compounded by physical inactivity resulted in a gradual increase in the risk for CVD since the past two centuries which precipitated as a sharp rise in the incidence presently encountered. The modality based on the concept of Life Style Modification, by regulated diet, physical exercise, stress reduction and cessation/reduction of tobacco habit, for prevention of CVD has been the most advocated preventive approach for quite some time. Amongst the earliest observation indicating a correlation between dietary fat and elevated blood lipids was that of Kinsell (1953). It was noted that a certain type of fat (polyunsaturated fatty acids, PUFA) could lower blood cholesterol although saturated fatty acids were mainly responsible for elevated plasma lipids. Bronte-Stewart (1956) demonstrated that by simply adding extra PUFA-s to diet dramatic lowering of elevated total cholesterol could be achieved. Much later it was shown that altered fat metabolism was associated with coronary artery disease (Siguel *et al* 1994) This report paved the way for a promising research on atherogenesis with implications for dietary modulation for prevention of CVD (Ross, 1993). In spite of the complicated relationship between fatty acid metabolism, amount and type of fat intake and chronic heart diseases it was generally accepted that lowering of total plasma cholesterol by dietary modification could be considered as a useful and practical approach for prevention of CVD. As an outcome of these findings, recommendation made in the 20th century for prevention of heart diseases therefore was to avoid weight gain attributed to excessive consumption of fatty food, along with regular exercise or physical activity. Additionally, prescription of anti-oxidants and vitamins viz. E and C was suggested for protection of damages caused by products of fatty acid metabolism (Oliver *et al* 1995). This was accepted worldwide including India. Since the late nineties the hypothesis that anti-oxidant vitamins may reduce risks of CVD initiated much research work and epidemiological study which provided support for use of anti-oxidants to reduce chronic heart diseases. The practice of prescribing supplemental E, C and β carotene to high risk groups for CVD became a routine preventive strategy. However the actual public health benefits of this approach still remains debatable (Buring & Gaziano, 1997). The general nutritional guideline currently in practice for reducing CVD risk consists of control of body weight by healthy diet composed of minimally refined grains, low simple sugars, moderate red meat, fats and oils and good amount of fresh fruits and vegetables (Willet, 1997).

It is evident that one of the powerful predictors of cardiovascular mortality is cigarette smoking and the relative risk of sudden cardiac death is about ten times higher in smokers than non-smokers (Kannel *et al*, 1987). It has been shown that risk from tobacco is dependent on the quantity and duration of smoking habit. The development of atherosclerosis is also strongly associated with tobacco habit with smokers having twice as many advanced lesions than non-smokers (Celermajer *et al*, 1993). But tobacco smoking is considered as the most preventable cause of heart diseases. Hence "cessation of smoking" concept or in fact avoidance of all sort of tobacco habit, has gained ground as one of the most important CVD prevention approaches. The principal guideline of action for restriction or ban on sale of tobacco products sale emphasises on the concept of "Education, awareness and advocacy". Cessation of tobacco habit is seen as a significant CVD risk reduction procedure and already it has been found to be effective in people of all age.

The present review clearly indicates that the genesis of preventive concepts for CVD was seeded in the remote past. As mentioned earlier, excessive physical exercise, purgation, anxiety, fear and family management disorders were thought to be among the causative factors of heart disease (*CS Cī* 26.70-73) which obviously suggest stress as a risk factor for CVD. This is supported by modern research. Furthermore, the preventive methods for heart disorders recommended were avoidance of the major causes of these diseases through leading a life of health, strength and happiness promoting paths and knowledge (*CS. Sū* 30.13-15). This has also relevance in terms of modern approach to CVD prevention. It is not possible to assess whether the ancient knowledge was merely observational or also involved experimental studies. However the modern preventive concepts were based on extensive epidemiological and experimental evidences, and developed perhaps more scientifically with the understanding of pathogenesis and causal factors for the diseases. Despite advances made in the field of treatment, the rising trends of CVD in epidemic proportions worldwide reveal that it would be impossible to manage them in the absence of adequate and timely preventive interventions. During the 1960s the major issue was whether CVD could be prevented or not, but by 1980s a broad consensus was arrived that prevention was indeed possible (WHO, 1985). The WHO expert committee strategy recommended (a) Population Strategy for prevention in whole populations with primordial prevention (b) High Risk Strategy and (c) Secondary Prevention. These strategies were aimed to ensure that in the first place the diseases do not occur, to develop protocols for identification of high risk groups as targets for preventive initiatives and reduction of mortality and disability. Prevention concepts for CVD is based on the realization that this group of diseases have multifactorial aetiology and therefore their prevention demand a complex mix of integrated interventions. Simple life style modification coupled with technologically advanced detection and intervention procedures were therefore recommended for implementation as an important arm of public health care. Earlier only tertiary prevention was attempted for delaying disability and premature death. With better knowledge on risk factors and updated health promotional services aimed at early detection and diagnosis, especially in high risk groups, primary prevention has become possible. A holistic approach for handling the complex medical and social needs is also emerging. The outcome of these diverse but integrated approaches for stopping or delaying the onset or checking the disease progress, is likely to impact on the incidence, prevalence and mortality rates from CVD by mid twenty first century. To ingrain a mass consciousness and awareness on heart health World Heart Day is observed every year on 7th of April, which also marks the anniversary of the founding in 1948 of World Health Organization, the "watch tower" of global health.

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