Presidential Address 1991

Sudden Cardiac Death

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Journal of the Ceylon College of Physicians, 1992, **25**, 1-5

The reason I have chosen this title for my address is because I have been interested in cardiac resuscitation and have done research on Ventricular Defibrillation using low energy for over a decade. Also I feel that no one in this audience would not be interested in this subject.

I do not have an easy task as I have to keep the doctors happy as well as keep our distinguished guests from being bored. I shall however do my very best.

The first record of sudden death was the death of the Marathon Runner Phillipides in 490 B.C. Since the U.S. Army Doctors have studied 45 marathon runners who died suddenly. Most were due to heart disease. In 1707 Lancisi a Roman Physician described an epidemic of sudden deaths in Rome which occurred in 1705. "Most were wealthy males, living in luxurious style. Common people, females and people content with respect to food, drink and sexual life were preserved"

The most recent sensational sudden death was that of the famed American basket ball player Hank Gathers who collapsed and died in full view of thousands of stunned fans and spectators, during a series in Los Angeles. The cause of death was cardiomyopathy.

There are many definitions of sudden death. But "Death due to a primary cardiac cause occurring within one hour without symptoms", is perhaps the most appropriate definition for practical purposes.

* *President, Ceylon College of Physicians 1991.*

There are about 200-400 thousand cardiac sudden deaths per year in the United States.[1] Douglas Zipes the Cardiologist states that 1 death occurs every minute in the U.S. In U.K. about 60,000 die per year from sudden cardiac death. A recent report state that in China 1.8 million sudden cardiac deaths occur per year. In Sri Lanka, sudden cardiac deaths account for more of the sudden deaths than any from other cause. Exact figures are not available. In general in industrialized countries around 19-159 deaths occur per 100,000 per year for males. For females the incidence is much lower 2-35 deaths per 100,000 per year. This female advantage should however not be viewed with comfort by women because every male death creates a widow or the loss of a bread winner.

90% of sudden cardiac deaths (S.C.D.) are due to coronary artery disease. 10% is due to Mitral Valve Prolapse, Bacterial Endocarditis, Obstructive Cardiomyopathy, Myocarditis. Rheumatic Heart Disease, Congenital defects, Valvular abnormalities and prolonged QT interval syndrome.

The epidemiology is bimodal, the highest deaths occurring in the 1-6 months age group. Three of 1000 live births have sudden cardiac death. Next highest is in 35-70 year age group. Males are chiefly affected and comprise 70% of deaths. 60% of the deaths occur outside hospital.

The post mortem findings in sudden coronary death are thrombosis which occurs in 20% but in contrast in transmural infarction 90% have thrombosis. Atherosclerosis is extensive and severe and in one quarter the coronary

tree is narrowed more than 75%. The right coronary tends to be more affected. This supplies the S.A. & A.V. node and therefore possibly causes S.C.D. More than two-thirds have increased heart weight. The left anterior descending is narrowed in 96%, the right coronary in 70%, the circumflex in 66%, and the left main in 34%.

The factors predisposing to sudden death are

1. Poor left ventricular function.
2. Extensive coronary disease.
3. Frequent ventricular ectopics.
4. Exercise induced Angina.
5. Exercise induced Hypertension during a Stress Test.
6. Advanced age.

The first recording of sudden cardiac death was of 61 year old Manager of an International Company who had an infarct at Age 42 and another at Age 55. He was provided with a 24 hour ECG recorder and the following events were noted on the day of his death[2].

5.02 Left office on foot for the Station.
5.17 Boarded train.
5.27 Was found slumped against window.
5.28 Was unconscious and had jerking movements.
5.30 Was grey and had no pulse, CPR attempted.
5.55 Pronounced dead.

The Tape Recording showed the following

5.00 Normal Heart Beat.
5.01 2 premature ventricular beats.
5.03 Sinus tachycardia 165/min.
5.20 Heart Rate 90/min.
5.22 Ventricular premature beats.
5.25 V.p.b. occurred on T wave followed by ventricular tachycardia and ventricular fibrillation.
5.48 Ventricular stand still.

This was the first time a recording was made immediately preceding and at the time of death.

The prodromal symptoms 2 weeks pior to sudden death were

1. Fatigue.
2. Shortness of breath.
3. Chest pain.
4. Cough.
5. Dizziness.
6. Palpitation.
7. Fainting.

Fatigue was the commonest and occurred with increasing frequency. Of course it would not be practical to predict sudden cardiac death those having fatigue especially in a tropical humid climate.

The most alarming epidemic of sudden cardiac death has been reported in the 10,000 construction Thai workers in Singapore. About 200 have died since 1985. They were young and were poorly paid, malnourished and living under very basic conditions. No deaths occurred while working. Deaths occurred while sleeping usually, mostly between 3 & 4 A.M. They did not die quietly. Witnesses say they screamed and thrashed around before dying. Autopsy did not reveal coronary artery disease and the hearts were normal except for sub-endocardial haemorrhages. A similar incidence had taken place among the Hill tribe of Laos who fled to Thailand, and in Kong Keng a village 300 miles from Bangkok. Again males 25-45 were mostly effected. However the highest death rate has been in Hatni-Kong Refugee Camp where 574 deaths occur per 100.000 men, which is 5 times that in the West. In some families all male siblings were victims of S.C.D. woman were affected. These sudden deaths have been studied by American Epidemiologist Ron Munger who found that their diet of highly polished rice gave them a Thiamine deficiency which was confirmed by low blood Thiamine

levels. In world War II, Ancel Keyes studied conscientious objectors who volunteered, to be on the Thiamine excluded diet. These subjects after a period of time showed prolonged Q.T. intervals, which were reversed with normal diet. More than 10% of the Thais studied were also found to have prolonged Q.T. interval beyond 400 milliseconds. Their Thiamine deficient diet it is hypothesized gives these workers a prolonged Q.T. interval Stress is probably trigger that gives them sudden death. A large number of Mong refugees who have been settled in St. Pauls Minnesota are still predisposed to sudden cardiac death in spite of better diet and living condition confirming a genetic predisposition.

The prolonged Q.T. interval syndrome is an is a congenital condition where the ECG shows the interval between the Q wave and the T wave is extended. This abnormality can predispose to sudden cardiac death. It is suggested that in these persons the sympathetic nerves to the heart are unequal. This condition can be inherited and S.C.D. or fainting can occur in early life due to electrical instability of the heart. Treatment by Beta Blockers and Stellate ganglionectomy has prevented sudden cardiac death.

It has been observed that after Acute Myocardial Infarction the Q.T. interval can be prolonged in some patients and predispose them to sudden cardiac death. The Q.T. interval can be also prolonged in other conditions like Hypomagnemia and Hypokalaemia.

Psychological stresses have been known to cause sudden deaths,bereavement, grief, chronic depression, humiliation, hopelessness, joy or being over joyed, and fear.

Bereavement has been shown to increase sudden fatality. During the first 6 months of the loss a spouse, 4,486 widowers, 55 years or older had an increment in death rate that was 40% above the expected rate for married men matched for age. It is observed that a spouse may die with a year of the death of the wife or husband.

It has been reported that Grand Rounds can be a danger to patients with Myocardial infarction[3].

A five fold greater incidence of sudden deaths occurred during medical daily ward rounds than would have been anticipated had these deaths been random. The Chief Physicians round held once weekly, accounted for half the sudden deaths.

Tachycardias has been reported - amongst students presenting cases and during rounds No. S.C.D. have yet been reported fortunately.

The autonomic nervous system plays a part in sudden cardiac death. The heart is not an isolated organ it is linked to the brain by the sympathetic nerves and the vagus which speeds and slows the heart rate respectively. Sympathetic stimulation may lower the threshold for ventricular fibrillation. In contrast vagal stimulation may increase the threshold for ventricular fibrillation.

Dr. James Skinner of the Methodist Hospital in Houston has studied the relationship of the brain to the heart. The frontal lobe regulates the inflow of sensory information into to the cortex to control the state of consciousness and simultaneously descending neural projection out of the brainstem via peripheral nerves link the brain to the heart which is richly innervated. The vagus and sympathetic nerves supply the right atrium equally but the ventricles are richly supplied by the sympathetic fibres.

James Skinner has conducted experiments on pigs and found that tying of the coronary arteries induced S.C.D. easily. When the pigs were adapted to the staff of the lab. S.C.D.

was less easily induced by occlusion of the coronaries. It was also observed that a cryo-needles inserted into the pathway in the frontal lobe blocked neural impulses to the heart preventing S.C.D. in pigs, when their coronaries were occluded.

Just over on a hundred years ago Dr. John MacMillian of Kiltarlity in Invernesshire, long before electrocardiography was invented hypothesized that the major cause of S.C.D. was ventricular fibrillation. He based this on experimentation and comparative physiology. He was dead right.

The mechanism of death in 75% SCD is due to Ventricular Fibrillation. In the balance 25% it is due to Asystole, Brady cardia and Sinus arrest.

Ventricular fibrillation is the uncoordinated movement of thousands of muscle fibres or myofibrils of the heart which instead of contracting in a concerted fashion, writhe like a bag of fine worms producing no effective pump action.

This state of ventricular fibrillation of the heart is due to electrical instability and not due to irreversible damage to the heart's pump or heart muscle. If treated quickly with a shock from a defibrillator the fibrillating heart can be restored to normal rhythm and effective action and patient can return to normal life again.

The heart action must be restored within 5 minutes to supply blood to the brain. Immediate cardiac massage and mouth to mouth respiration can restore the circulation but ventricular fibrillation nearly always requires Defibrillation.

Defibrillators are expensive, heavy and not easily available. The Standard Defibrillator is still of considerable size and weight due to the high voltage required to produce energy for external defibrillation. The smallest defibrillator weighs 2.5 kg. American Cardiologist Irvin Wright states that

"High priority should be given to development of a small low cost defibrillator that could be kept in every Nursing Station or possible even carried in a physician's bag for use in when an unexpected cardiac emergency occurs."[4]

If Ventricular fibrillation is reverted to normal sinus rhythm within 30-40 Secs. many biochemical sequelae such as acidosis are avoided and the need for cardiac massage and endotracheal intubation eliminated.[5]

We have therefore attempted to produce a smaller defibrillator. In open heart surgery defibrillation requires only 5-10 Joules, with the chest closed defibrillation it requires 200-400 Joules for which a voltage 6000-8000 volts is required.

In our experiments in low energy defibrillation, using an Intra cardiac needle[6] and transvenous intra cardiac catheter we found that the energy required was very low, amounting to 5-10 joules.[7,9]

Catheter defibrillation has been deployed in the implantable automatic defibrillator which is now routine use.

Professor Schwartz of Milan produced ventricular fibrillation (VF) in dogs after occluding their coronaries by remote control while on a treadmill.[5] In some dogs VF was easily induced. In others it was difficult as they had good baro-receptors. Baroreceptors are organs in the neck which are sensitive to Blood pressure. When sympathetic stimulation increases the Blood pressure, the rise which is detected by the Baro-receptor causes vagal stimulation which slows the heart rate and reduces that the occurrence of sudden cardiac deaths. He hypothesized that patients who after a heart attack, had powerful Baro-receptor had less sudden cardiac deaths. Those with weak Baro-receptor has 10 times greater

risk of S.C.D. Thus sympathetic stimulation increases S.C.D. and vagal stimulate reduces sudden cardiac death.

The conditions where there are weak Baroreceptors are

Diabetes Mellitus
Familial Dysautonomia
Shy - Drager Syndrome
Alcoholism
Chagas Disease
Guillan Barre's Syndrome
AIDS.

How does one prevent sudden cardiac death. Since 90% of S.C.D. are due to Coronary Artery Disease the first steps would be obviously to remove the risk factors that lead to Coronary Artery Disease. i.e. avoid smoking, control hypertension, control cholesterol and obesity. Exercise, combating stress, relaxation programmes and meditation which are now advocated to prevent coronary artery disease. It as been shown in a study of American doctors that moderate drinkers have less risk of heart disease than non-drinkers and heavy drinkers.

Having taken the preventive measures how does one know one has Coronary Artery Disease in absence of symptoms, and when E.C.G., X'Ray and Stress Test etc are normal. A Coronary Angiogram is the only way, but is in itself not without risk. We await a non invasive method of displaying the Coronary tree.

Management of those at risk

1. Coronary By pass Surgery
2. Angioplasty
3. Automatic Inplantable Cardiac Defibrillators
4. Aneurysectomy
5. Pace Makers
6. Drugs - Beta-Blockers and Amiodarone
7. Electrophysiological studies by pacing stimuli may be used to select drugs, perform Surgical or catheter ablation.

"The science of the precognition of sudden deaths is seen to be not merely useful but extremely necessary to Physicians. Since the teacher of our art (Hippocrates) clearly shows that man not only absolves himself from all blame, but acquires the name of and the admiration owed to a good Physicians, when he, unable to make every one well, at least divines and foretells what is about to happen" (G.M. Lancisi 1707)

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