Leading Article

Current concepts of normal ageing and the achievement of successful ageing

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In terms of man's existence on this planet the 20th century has witnessed remarkable advances. We can think of several achievements, for example, space travel, computerisation, and in the medical field, the discovery of antibiotics, and advances in immunology and transplantation.

But we often forget changes in man himself. At this stage, we must consider two concepts: life span and life expectancy. Life span — is the maximum period of time that an animal can live, given the best of circumstances. For man, this is about 115 years today.[1] 3 to 4 million years ago the human life span was 57 years. It increased until about 100,000 years ago when at the stage of Neanderthal man, it seemed to halt. We know this from examination of fossils. The evidence is based on the observation that the life span of most mammals is directly related to the ratio of the average weight of the adult mammalian brain to the average weight of the adult body.[2] Life expectancy is the 50% probability of how long a person will live. In this century, life expectancy has increased in most parts of the world. In Sri Lanka, it has increased from 32.7 years for males and 30.7 for females in 1920 to 67.8 in males and 71.7 in females in 1981.[3] In the USA it increased from 46.3 for males and 48.3 for females to 71.5 for males and 78.4 for females in 1987.[4]

Increasing longevity has been associated with a progressive decrease in the rate of ageing.[5] With this increased longevity there has been a dramatic increase in the number and proportion of the elderly. By the year 2000 there are expected to be 600 million elderly, which will increase to 1.1 billion by 2025. The W.H.O. definition for elderly (1980) was people over the age of 60 years. But when does ageing commence? This would depend on the view point, and ageing can be defined in chronological, social, economic or biological terms. We shall look at the human life cycle and try and understand ageing from a biological point of view. At conception, the fertilised ovum is an organism weighing a minute fraction of a gram. This grows rapidly to the time of birth, and then continues to grow to an average adult who could weigh 70 kgs. Growth then seems to halt and ageing commence. Normal ageing is defined as the structural and physiological changes that occur after maturity under optimal conditions.

There is a misconception in society, that normal ageing implies an irreversible process of gradual bodily disintegration and that all physiological processes decline, but this is not necessarily so. We all have at some time come across 90 year old people without physical or mental handicaps, psychologically alert and retaining their ability to participate in society. In fact you could see four definite patterns of age change:[6]

1. Some functions that do not change at all, although there may be changes in various contributing factors. For example, the resting heart rate in young adults or in 100 year olds is still the same, at about 70-75 per minute; plasma electrolyte levels remain constant; some immunological responses remain constant; the serum thyroxine level remains constant even though its rate of production and its rate of ulilization are decreased. And as you will see later, intelligence itself does not seem to change appreciably throughout life.

2. The body gradually loses its ability to adapt to change in its environment and therefore makes man more susceptible to disease as he ages. The body gradually loses its ability to withstand stress, whether it be to undertake severe exercise or to cope with a period of dehydration. Under stress, there may be rapid and drastic changes in fluid and electrolyte balance. The response to sodium depletion is poor and the inability of the kidneys to adequately concentrate urine results in dehydration.

3. Compensatory changes may counteract the consequences of ageing. For example, exercise pro-

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gramms can improve the aerobic capacity of the aged. Similarly, proper nutrition can affect the ageing process.

4. Changes which are entirely due to age. It is customary for us to estimate age based on these changes of ageing. It is not uncommon for people to say "you do not look your age" based on a person's appearance, or say "your heart is like that of a twenty year old" based on clinical features. The normal ageing process affects the physical appearance. The changes in the appearance of the skin are commonly used to estimate age. Wrinkles appear and sagging of the skin occurs due to loss elasticity and cross-linking of elastin fibres, by cross-linking of collagen fibres and decrease in the subcutaneous fat in the skin. The hair also gets thinner and greyer and often becomes brittle. A very important changes that occurs is the reduction in the cell mass of the body. There is a reduction in the lean muscle mass of about 30% between the ages of 30 and 70 years. This is associated with an increase in the body fat with ageing. Older people of the same weight and height have more body fat and less muscle. This increase of body fat is mainly around the abdomen in men. In females the excess body fat is laid down in the hips and thighs, and may amount to an increase of 35% in body fat. Muscle strength is also reduced, mainly due to muscle cell atrophy, particularly in fast stretch fibres. These fast stretch fibres begin to act like slow stretch fibres responsible for maintaining posture. Bone strength is reduced, due to a mineral loss with ageing. In males this could be about 10% from the age of 20 to 60, while there could be a drop of 25% in post-menopausal females, increasing the risk of fracture in this group.

In the central nervous system, there are many physical and biological changes. The clinical effects are not as alarming. There is a reduction of nerve cells and motorneurone fibres. In fact, throughout life, There is a neurone cell loss of about 50,000 cells a day. Fortunately we are born with an estimated[100] nerve cells, so that there are enough nerve cells to last our life-span. But fortunately the functional effects of these changes are not very marked with normal ageing. The progress of intellectual ageing was studied in greal detail in the Seattle Longitudinal study[7] where large numbers of individuals were followed up for seven year intervals over the age range from 25 to 81 years. On average there was a gain in intellectual test results until the late 30s or early 40s were reached and then there was stability until the mid 50s early 60s. Beyond 60, seven year interval changes were statistically significant but affected only less than one third of the studied participants until the age of 74. Even by the age of 81 only 30-40% of the persons studied were affected. Further studies have shown that those individuals who were at risk from cardiovascular disease tended to decline earlier on average on all mental abilities studied than did individuals not so affected. Another very interesting finding in the Seattle study was the effect of intervention in the form of cognitive retraining. It was found that significant gains could result following a period of retraining and that approximately 40% of the subjects returned to the level of 14 years previously.[8] Memory capacity decreases with ageing. But it is retrieval of facts that is more impaired than storage and assimilation. Older people compensate for their deficits by acquiring different ways of learning and by utilizing broader previous experience.[9] However the elderly have susceptibility to aberrations of mental function, probably due to diminished adaptability to adverse psychological or medical factors or side effects of drugs. These aberrations are particularly likely to be seen following stress.

Cardiovascular function at rest is not significantly altered. However, exercise performance declines progressively with age. There is a rise of blood pressure with age. The potential functional state of an elderly individual without cardiac disease was beautifully illustrated in a single subject study by Webb in 1977[10]. He reported the physiological characteristics of a world champion distance runner aged 77. The subject held 14 recognised world records in track for competitors in the 74-76 year old category. At age 77, the individual ran record races of 1 mile in 6 minutes 53.6 seconds and 10,000 metres in 47 minutes 30 seconds. Physiological studies of the subject revealed that he was slim and trim, height 5' 9 1/2" and weighed 151 1bs. With resting blood pressure 120/70 mmHg, resting heart rate 55 beats/minute, maximum heart rate 160 beats/minute, and maximal minute venlilation of 53 litres/minute (normal range 45-80 litres/minute). This single subject study provides some insight into the optimal performance that can be achieved in a trained, elderly individual without complicating cardio-pulmonary disease. This is an image that we should keep in mind as we care for patients in older age groups.[11]

Respiratory function deteriorates from the age of 25. The chest shape alters with a gradual tendency towards a barrel chest. The chest wall stiffens with decreasing muscle strength. The lungs lose their elasticity but the total lung volume remains constant. The vital capacity, the forced expiratory volume in one second and the forced vital capacity are all diminished. However the ratio of forced expiratory volume to forced vital capacity remains constant. There is a reduction in the diffusing capacity resulting in a reduced partial pressure of oxygen in the

blood. Therefore, in a 70 year old, a partial pressure of 70-75 mmHg would be regarded as normal.

Renal function is less affected with ageing, as we start with an excess capacity at birth. There is loss of cortical mass and the number of glomeruli resulting in a decrease of 20% of renal mass by the 80th year. Renal blood flow decreases by 10% per decade. Therefore a young adult with a flow of 600 ml/minute would have a flow rate of 300 ml/minute at the age of 70 years. Fluid and electrolyte balance is maintained at rest, but very rapid and dramatic changes may occur in fluid and electrolyte balance under stress. There is a diminished ability to concentrate urine, so that under conditions of stress, such as fever or fluid depletion, dehydration occurs rapidly. Young people produce a larger volume of urine during day time, rather than at night. But the aged produce equal volumes of urine day and night. A result of this is that nocturia is a common and normal feature of ageing.

Studies of normal ageing are concerned with the psychological and biochemical changes that occur with ageing in the absence of disease. However, the older a person becomes, the more likely that disease is superimposed on the ageing changes, and the two become difficult to distinguish. In many important physiological systems, the effects of ageing are much more modest than was previously expected. Removal of individuals' sub-clinical disease from study population has led to findings that effects of age on a number of important variables, especially the cardiovascular system, are minimal. Most prior studies of the physiology and biochemistry of ageing tended to treat age as a sufficient explanatory variable if pathology had been excluded. This simplistic approach neglected the important influence of non-pathological factors, related to health, behaviour and life-style, which are increasingly recognised as having a very important influence on physiology. Differences in exercise, body composition, diet, alcohol and tobacco use, and other factors, while they may not qualify as "diseases", modify numerous physiological variables.[12] Ageing is now believed to be multifactorial. The life-span is genetically derermined. But superimposed on this genetic program are environmental and lifestyle factors that affect ageing. Some of our lifestyles are detrimental, because the human species adapted during evolution to environments very different to those in which we mostly live today. Current concepts suggest that ageing is caused by environmental and intrinsic factors that damage molecules, cells and tissues. Protection is provided against these harmful influences by genetic responses that protect molecules and cells and reverse the damage. The exhaustion of these genetic defences with age may leave the individual defenceless and at an ever increasing risk of disease.[13]

Recent advances in molecular biology have described linkages between genotypes and longevity. They may provide a stimulus to studies of immunological components of ageing in the future. Hart and Setlow, in 1974,[14] showed that for a number of mammalian species, the extent of DNA repair was highly correlated with maximum life span. Human beings who live twice as long as the chimpanzee were found to have twice that animal's capacity for DNA repair. Intrinsic ageing is now thought to be due to incomplete repair of random damage to body components. Incompleteness of repair was not eradicated during evolution, because of the necessary trade off in terms of genetic survival, between investing energy resources in repair or investing in a higher rate of reproduction, A species betters its chances of survival by investing its resources and energy on increasing opportunities for reproductive longevity. Thus animals are mortal and age because investment of resources in the maintenance of youth does not favour the survival of the species as much as does investing those same resources in strategies for reproductive success. During the post-reproductive period, the animal functions on its excess capacity. This physiological reserve of energy and functional capacity does not renew at the same rate at which it incurs losses, thus an increase occurs in molecular disorders. Random errors that occur at the molecular level result in some of the normal physiological losses of ageing. These changes increase the vulnerability of the animal or human to accidents or disease.

Aged animals are not essential for the survival of any species, thus there is no selective advantage favouring their survival. Instead of asking "Why do we age?" the right question should be "Why do we live as long as we do?"[15]

Longevity depends on the realization of an individuals' genetically determined program of life and development. Animal experiments have shown that age related changes in laboratory animals are responsive to factors in diet, hormones and drugs. It is now believed that lifestyle, diet and familial factors also play an important part in the ageing process in man. It is also now believed that by modifying the environment and lifestyle, we may alter the proportion of the population which achieves, without disability, its genetic potential for longevity. In many data showing substantial average decline with age, one can find older persons with minimal physiological loss, or none at all, compared to the average of their younger counterparts. These people might be viewed as having aged successfully with regard to the particular variable under study. And people who demonstrate little or no loss in the constellation of physiological functions would be regarded as more broadly successful in physio-

logical terms. They, in combination with people who show the typical non-pathological age related losses that we purport to designate as usual, constitute the hetero-geneous category of the normal (ie. non-diseased) in any age group. A distinction between usual and successful ageing is urged similarly by recent discoveries with respect to risk factors of specific diseases.[16]

Moreover, such changes which have been interpreted as age intrinsic, are turning out to be usual in prosperous industrial countries but not in pastoral and traditional agricultural societies. Successful ageing not only involves enjoying good physical health, but encompasses many other important aspects. It also describes a positive adaptation as reflected in contentment and satisfaction with quality of life as perceives by people in their advanced years. This would necessitate an adequate income and proper housing, as well as a supportive social network and adequate transport facilities. As regards physical criteria an elderly person would like to be independent in activities of daily living, such as walking, bathing, dressing, eating and toileting.[17]

However, material well-being does not ensure happiness or fulfillment, and hard times do not always lead to despair and feelings of victimisation. Results of research studies suggest that the antecedents of successful ageing partly involve adaptive personal resources and historical factors, interacting with social conditions. Problem situations marked by conflict and stress earlier in life may initiate an organising function in development, because they often require adjustments that structure and restructure life trajectories.[18] Hence the ageing populations in developing countries, with their cultures based on eastern philosophies, are by no means disadvantaged in their attempts to achieve successful ageing.

Why does maintaining active social interaction apparently contribute to longevity? It is generally accepted that the more social interaction the older person has, the better a persons' health seems to be. It appears that these protective effects do not mediate themselves through the usual risk factors, i.e. social supports don't seem to lower blood pressure, reduce cholestrol and so on, so they are having some effect other than controlling known risk factors. Taking it a little further, why is it that certain people function very well with disease and others don't? One could describe a 75 years old man with diabetes and a history of cardiac problems or a stroke, and it could be that we are describing a man who is in a nursing home, or sitting on the Supreme Court bench or practicing medicine, such is the tremendous variability among aged individuals. Two concepts would helps us to understand these differences.[18]

There are:

Vitality: which is a general measure of a person's psychological and physical status, biological, and psychological factors, all of which are continually moulded by the environment.

Resillence: Directly proportional to vitality is resilience which is a person's capacity to respond successfully to physical, psychological, or social stresses. Studies are therefore being conducted to determine the underpinnings of vitality and resilience, in the hope of not only understanding successful ageing, but also for devising supportive interventions. Current research in ageing is directed towards developing methods to prevent or slow environmental degenerative processes and to enhance individual performance. Future studies must also address the strength and competencies that people develop over a lifetime, and which they can use to transform what might be a final phase of decline and renunciation into one of integrity and intergration.

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After reading an article on ageing, Dr Hans Popper, a distinguished physician and researcher in liver disease, who is himself 84 years old, wrote an eloquent letter an extract of which follows:[20]

Dr Popper writes —

"Being prevented from either enjoying or performing activities which I liked before, including attending cultural events which require acoustic adequacy, e.g. concerts, theatres, movies, even TV or recreational sports, I am spending more time on scientific activities than before ageing. This means more hours at work and is rewarded by more pulications and also by sharpening productivity. My co-workers believe that I am developing more decisive and useful working hypotheses than in previous years. Thus intellectual compensation for physical disability may be the therapeutic principle beneficial for the individual and society."

"Challenge involves furthermore a problem with which I am dealing, namely periodic tiredness, an impediment even in successful ageing. My own friends, co-workers, family's and even my physician's reactions to this periodic fatigue, is to suggest to reduce extensive intellectual activity and to rest. It is the accepted wisdom that

the aged person has earned rest by her or his previous achievements. I have been instinctively objecting to this advice. It is clear to me that this advice is bad, because it induces a negative feedback mechanism, in that deserved rest accentuates fatigue and facilitates depression. I believe the older person should be stimulated during episodic tiredness, or else drive himself or herself. This might include reduction of sleep from excess to a reasonable length because excess sleep is giving in to depressive tiredness rather than desirable relaxation. This consideration leads me to postulate a paradox, not stressed in the gerontological literature; compensation, challenge, and discipline are the keys to successful ageing aside from genetic predisposition and environmental factors."

Dr Popper has illustrated older people can rise to the challenges of ageing, and how active they can remain, even if their activities have had to change. We must work towards keeping older people active as community members by using, as Dr Popper says "The intellectual potential in the aged, after their retirement", helping patients practice health promotion and disease prevention techniques, and encouraging social and intellectual stimulation. Thus we will contribute not only to successful, but to productive ageing as well.

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