

THE PHYSIOLOGY OF AGEING

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ABSTRACT

Normal ageing is responsible for the finite life-span of the human race.

It is important for the doctor treating the elderly to know the difference between changes secondary to normal ageing and changes which occur as a result of disease.

There is ongoing research to increase our knowledge on the ageing process.

Age-related physiological decline results in defective homeostasis responsible for the susceptibility of the individual to succumb to minor stresses.

Knowledge of physiological decline in the various organs has clinical implications in the interpretation of physiological tests, especially when the organ systems are stressed, in the need to adjust dosage of drugs given to the elderly and in the understanding of some atypical presentations of illness in the elderly.

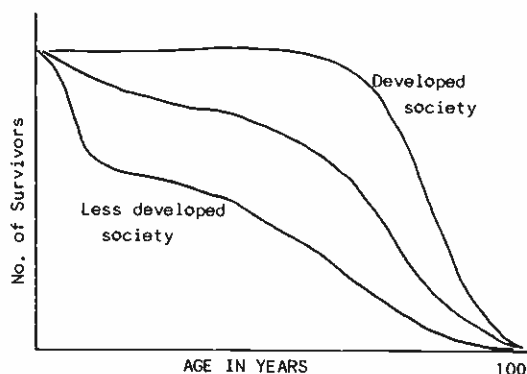
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WHAT IS NORMAL AGEING?

Normal Ageing by definition is considered a universal phenomenon resulting in progressive and irreversible changes responsible for the finite life-span of an organism. The epidemiological evidence for normal ageing is seen in the survival curves of various human populations (Fig 1).

Fig 1. Survival Curves of Various Human Populations



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These show that despite improvement in health care, the maximum life-span remains very similar in different human populations (approximately 90 to 95 years).

It is important for the doctor attending to an elderly patient to know the differences between changes secondary to normal ageing and changes which occur as a result of disease.

Only with a clear view of what is normal age-related changes can the physician properly evaluate and treat a sick old person.

Ignorance of these data has two equally dangerous consequences. First, normal age-related changes may be attributed to disease, provoking treatment that will certainly be ineffective and will likely do harm. Alternatively, disease effects are mistakenly attributed to normal ageing and neglected, allowing unchecked progression of a potentially treatable underlying disease.

Many theories have been put forward on ageing processes. Gerontological Research on human ageing covers a much wider scope than Geriatric Medicine. It covers such diverse aspects as epidemiological studies as well as research at molecular and cellular levels.

One of the great difficulties in Geriatric Medicine is still the differentiation of normal ageing from change secondary to disease processes and therefore reversible or preventable.

As an example, one could look at blood pressure changes with ageing. A longitudinal study on blood pressure changes with age has shown that there was a great variability in change with age. Most individuals showed some increase in both systolic and diastolic pressure, but some showed no change and small numbers of individuals actually showed decreased pressure with increasing age. Epidemiological evidence that factors in modern technological societies play a role in causing increased blood pressure with increasing age has been reviewed. Bushmen of Botswana and a New Guinea population apparently show no significant rise in blood pressure at the fifth decade, while pressure continues to rise in Londoners. Thus, while there appears to be a tendency for blood pressure to rise with age, this rise does not represent a true inevitable ageing process¹¹.

For practical purposes, a few generalised statements can be made :

- Variability is an important characteristic of age-related changes, both within individuals from organ to organ, and from individual to individual in a given population.
- Change in one organ does not predict or correlate with those in other organs.
- Age-related decrements are often exaggerated by negative effects of confounding environmental, dietary, genetic or life-style factors.

The physiological functions affected by ageing can be summarised below :

(1) Defective Homeostasis

An important generality about ageing is that every physiological process involved in the maintenance of homeostasis becomes less effective with increasing age.

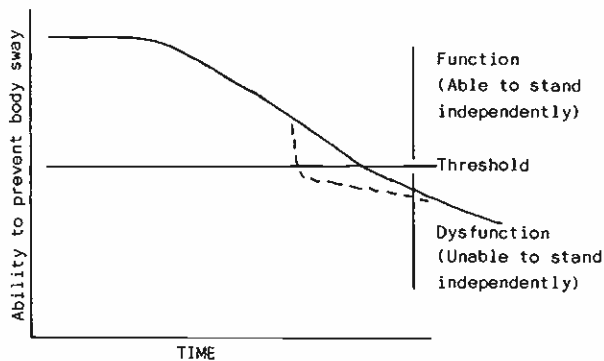
Often, the elderly individual may be able to function under basal and resting conditions but the age-related deficit is brought out when the system is stressed.

Such homeostatic mechanisms include :

- Ability to prevent orthostatic hypotension
- Temperature control
- pH control
- Glucose control
- Maintenance of fluid and electrolyte balance
- Ability to prevent body sway

Thus from a practical point of view the clinician should prevent, as well as look for precipitating factors that contribute to the change from 'function' to 'dysfunction'^[2] (See Fig 2).

Fig 2. Physiological Decline in Ability to Prevent Body Sway with Time and the Effect of Acute Stress on Function



(2) Cardiac, renal and pulmonary function decrease linearly with age after maturity

The following functions are affected :

- Elastic recoil of the lung
- Arterial partial pressure of oxygen
- Vital capacity of the lung
- Total body water
- Renal blood flow and creatinine clearance
- Maximum heart rate
- Maximum oxygen consumption

Clinical implications include the need to adjust dosage of drugs given to the elderly especially potentially nephrotoxic drugs. The formulae of Cockcroft-Gault and Lott-Hayton are valid for quick bedside estimation of creatinine clearance in healthy, ambulatory individuals not taking medications that affect renal function^[3].

(i) Estimated Ccr by Cockcroft-Gault formula :

$$\frac{(140-\text{age})(\text{Body weight in kg})^*}{72 (\text{Serum Creatinine})}$$

(ii) Estimated Ccr by Lott Hayton formula :

$$\frac{(140-\text{age})(\text{Lean body weight in kg})^*}{72 (\text{Serum Creatinine})}$$

* For female subjects, subtract 15% from each Ccr formula

(3) Endocrine changes with Ageing

Although decreases in the synthesis of sex hormones by the gonads after maturity and increased levels of pituitary gonadotrophins appear well documented, endocrine deficits in those systems necessary for the maintenance of homeostasis have not been clearly demonstrated.

It appears likely that reported changes in endocrine status with ageing are due to a large extent to overall physiological decline. The ageing organism appears able to compensate for any ageing processes that might involve the endocrine glands^[1].

(4) Age and Immune Function

Age-related alteration in normal immunological functions has been observed in human and in experimental animals. Most immunological activities show a decline with age.

It is clinically important that with alteration in immune functions with age, individuals become more vulnerable to infections, autoimmune and immune complex and cancerous diseases, as is the case in immunodeficient children and immunosuppressed adults.

It is not clear whether the decline in immune function is secondary to disease processes or if immunologic failure is part of normal ageing^[4].

CONCLUSION

Every ageing individual shows a generalised physiological decline. Thus normal value for physiological tests in which organ systems are stressed will become altered in all individuals with increasing age.

Similarly, drug metabolism and clearance change with age, suggesting that for some drugs, dose should also be altered with the increasing age of patients. Furthermore, reactivity as manifested by pain, fever, or an inflammatory reaction in response to tissue injury may be decreased in the ageing individual, and it may be difficult to recognize lesions and make diagnoses on the basis of physical signs in such individuals. It follows that all ageing individuals will become progressively less able to react to trauma and stress and less likely to survive a given amount of tissue injury.

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