RENAL FUNCTION AND AGE

ROBERT L. ORCHARDSON, *M.B.E., T.D.*, M.D., B.SC.
Largs

IN 1938 Lewis and Alving demonstrated that renal function deteriorates as age increases. This has been confirmed by many others, and it has been shown that this deterioration proceeds at a steady pace. Such work, however, was carried out on healthy subjects, or subjects suffering from specified pathological defects. This paper deals with an average cross-section of the ageing populace, healthy and not-so-healthy, and attempts to show the general picture of renal function as age increases under those conditions. The subjects were chosen at random, only those suffering from frank kidney disease being excluded. One hundred and fifty-two men and women, aged from 33 to 92 years were studied, 74 by the urea concentration test of McLean and 78 by the water concentration and dilution test of Calvert. In the urea concentration test it is considered that renal function is satisfactory if the concentration of urea in the urine rises to at least 2 per cent, and in the specific gravity test the criteria of Derow (1954) are employed. Thus, in the latter test, if water concentration is possible to a specific gravity of 1,025 or more, renal function is good (shown under 'G' in the table); if the specific gravity is from 1,018 to 1,024 both inclusive, renal function is said to be impaired ('I' in the table); and if the figure is 1,017 or less, function is poor ('P' in the table). Good diluting ability is accepted when the urine can be diluted to 1,003 or less.

Results

The results are shown in the table and in figures 1 to 5.

Figures 1a and 1b show that there is a wide individual variation in renal function at all ages. In order to show the mean variation in renal function at different age levels the value of this function is graphed against age, using as measurements the urea concentration or the range of specific gravity obtained, and shown in figures 2 to 5. It can be seen at once that while there is a general reduction in renal efficiency with advancing years, this decline is not uniform,

being interrupted by a decided dip in the seventh decade. However, reference to the table and to figure 1 makes it clear that even when the mean level of renal function is poor, the percentage of individuals within the group who show adequate kidney efficiency need not also be low. In the specific gravity series it is significant that the percentage of subjects showing frankly poor renal function increases as age rises, if one excludes the over-80 age group; but the percentage of those showing good diluting power does not show such a change, although here there is a low percentage figure at the 66–70 year level, and a very marked drop after the age of 75. There is a tendency for poor diluting power to be related to the incidence of prostatic enlargement.

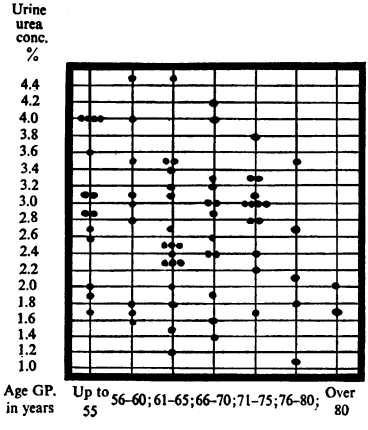

Figure 1a.
Urea conc. series.

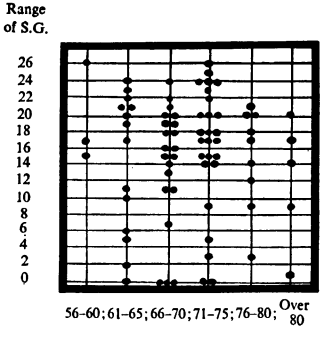

Figure 1b.
S.G. series.

Showing the age distribution of renal function findings

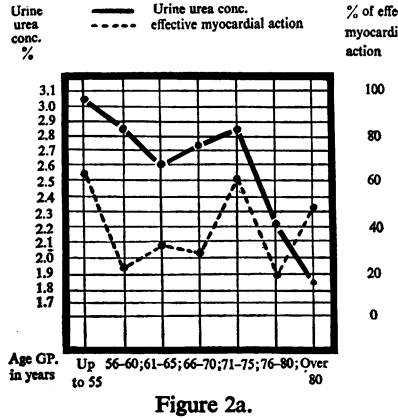

Figure 2a.
Urea conc. series.

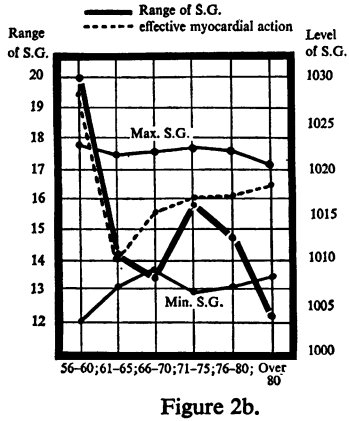

Figure 2b.
S.G. series

The relationship between renal function and myocardial action

In figures 2 to 5 the incidence of effective cardiac action, of the absence of atherosclerosis, of the absence of prostatic enlargement in the males, and the level of arterial blood pressure are graphed, along with renal function, against age. From these graphs it is clear that effective cardiac action and renal function are directly and closely related up to the age of 80 years, and that the graph for absence of prostatic enlargement follows that of renal function in general outline, although failing to show the sharp drop in the seventh decade. A generally similar trend can be discerned for atherosclerosis, but no such clear relationship between blood pressure levels and renal function can be seen. The diagnosis of atherosclerosis is based on the degree of patency or hardening of the perceptible peripheral arteries, on the result of examination of the retinal arteries, and on the locomotor response of the individual to normal exertion.

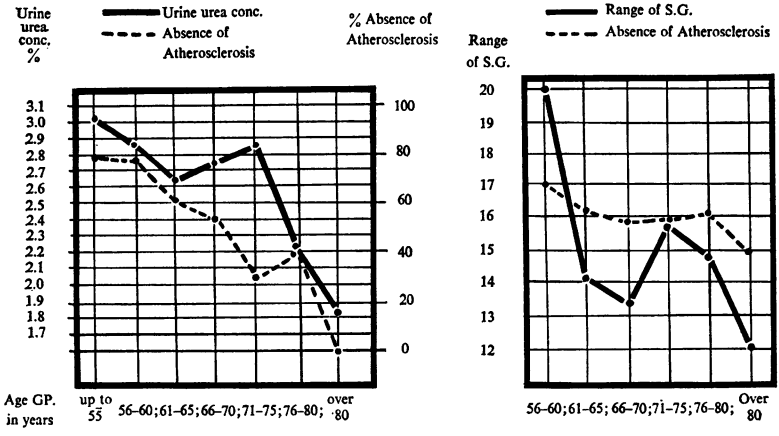

Figure 3a.
Urea conc. series.

Figure 3b.
S.G. series

The relationship between renal function and atherosclerosis

Discussion

It is accepted that increasing age tends to compromise renal function. In this investigation, however, it is apparent that mean renal efficiency drops markedly in the seventh decade, only to recover in the age groups immediately following. Therefore this decline at the 60–70 year level cannot be due to senescent change, but must be brought about by extra-renal factors influencing the kidneys. Of these factors, it is seen that the most important is cardiac action. It is probable that the stroke volume of the heart is the vital quality in determining renal efficiency. It is suggested that the low renal efficiency in the seventh decade shown in this

investigation is due to the presence of a high percentage of individuals who suffer from serious pathological defects, of which lowered cardiac efficiency is seen to be the most prominent. Since most of these individuals will be dead before the age of 70, the healthier survivors ought to show—as, in fact, they do—a much higher mean level of renal efficiency until true senescent degeneration sets in after the age of 75 years. It can be seen that in the over-80 age group effective cardiac action is quite good while renal function drops; this is probably due to the fact that atherosclerosis and prostatic enlargement are much commoner at this age level, and, by interfering with renal blood flow or by raising ureteric pressure, overshadow the effect of cardiac action, so that they must be considered the dominant factors at this age.

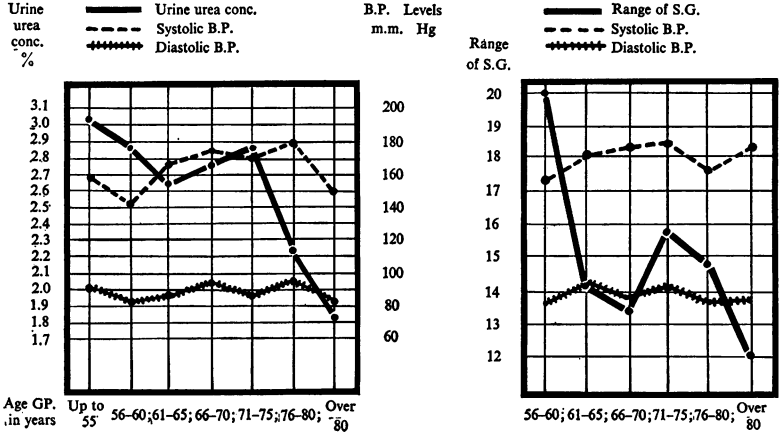

Figure 4a.
Urea conc. series

Figure 4b.
S.G. series

The relationship between renal function and arterial blood pressure.

That no exact relationship between arterial blood pressure and renal function is shown is probably because there are too many variable factors in the subjects for more than a general trend to be noted. However, it is seen that raised systolic blood pressure levels are not incompatible with reasonable renal function, nor are raised diastolic levels; indeed, they can enhance renal efficiency beyond the levels anticipated as Olbrich *et al.* (1950) have shown.

In brief, therefore, it can be said that the most important extra-renal factor in determining the level of renal function is the power of the heart; the presence in males of prostatic enlargement, particularly in the highest age groups, is next in importance, and atherosclerosis and arterial blood pressure levels exert appreciable, but not so potent, influence on kidney function.

UREA CONCENTRATION SERIES

Age group in years	*No. of cases*	*Percentage of total*	*No. of males*	*No. of males with prostatic enlargement*	*Average B.P. in mm. Hg.*	*Incidence of*		*No. of subjects showing adequate renal function*	*Average results per cent*
						Athero-sclerosis	*Impaired cardiac action*		
Up to 55	14	*19*	9	none	159/93	3	5	12	*3.03*
56–60	9	*12*	5	none	142/85	2	7	6	*2.88*
61–65	18	*25*	8	2	167/89	7	12	15	*2.62*
66–70	13	*17*	6	1	175/96	6	9	10	*2.76*
71–75	13	*17*	5	2	171/89	9	5	12	*2.87*
76–80	5	*7*	1	1	180/97	3	4	3	*2.24*
Over 80	2	*3*	1	1	150/85	2	1	1	*1.85*

SPECIFIC GRAVITY SERIES

Age group in years	*No. of cases*	*Percentage of total*	*No. of males*	*No. of males with prostatic enlargement*	*Average B.P. in mm. Hg.*	*Incidence of*		*Renal function shown by subjects*				*Average results*	
						Athero-sclerosis	*Impaired cardiac action*	*Concentrating power*			*Diluting power*	*Average max. & min. S.G.*	*Range of S.G.*
								G.	*I.*	*P.*			
56–60	3	*4*	1	none	159/86	1	none	1	2	none	1	1023.6/1003.6	20
61–65	14	*18*	9	4	171/96	6	10	4	9	1	6	1021.9/1007.7	14.2
66–70	21	*27*	11	7	179/89	10	11	7	11	3	5	1022.2/1008.7	13.5
71–75	26	*33*	15	9	180/94	12	12	10	12	4	8	1022.8/1006.9	15.9
76–80	9	*11*	6	3	164/85	4	4	4	2	3	1	1022.2/1007.3	14.9
Over 80	5	*7*	5	5	178/87	3	2	1	4	none	none	1020.8/1008.6	12.2

Table to show the relationship between age and renal function

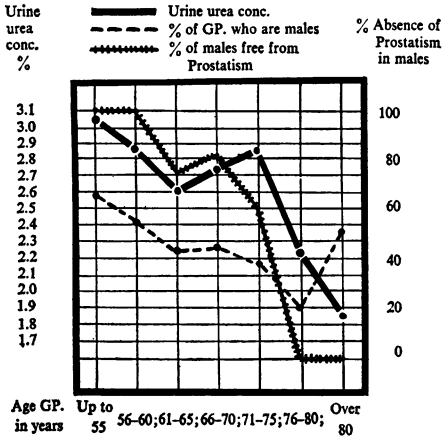

Figure 5a.
Urea conc. series.

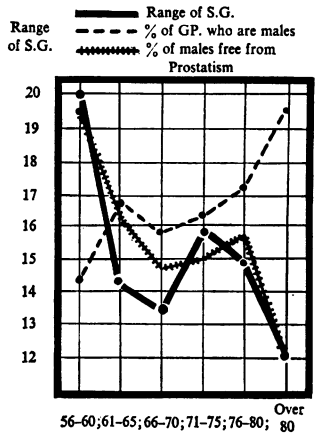

Figure 5b.
S.G. series.

The relationship between renal function and prostatism

Summary

The renal function of 152 male and female subjects is investigated by the urea concentration and the water concentration and dilution tests, and the results presented in age groups. It is shown that renal efficiency is lowered as age increases, and that there is a temporary drop in renal efficiency in the seventh decade. Senescent degeneration sets in after the age of 75 years. The level of renal efficiency attained is mainly determined by the cardiac power, and, in males, by the presence of prostatic enlargement. A high incidence of atherosclerosis appears to be associated with impaired renal efficiency. No definite relationship is seen between kidney function and the level of arterial blood pressure.

REFERENCES

Derow, H. A. (1954). *Circulation*, **10**, 114.
Lewis, W. H., and Alving, A. S. (1938). *Amer. J. Physiol.*, **123**, 500.
Olbrich, O., Ferguson, M. H., Robson, J. S., and Stewart, C. P. (1950). *Edin. med. J.*, **57**, 117.