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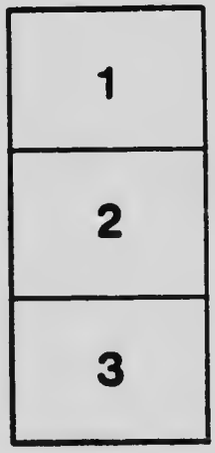

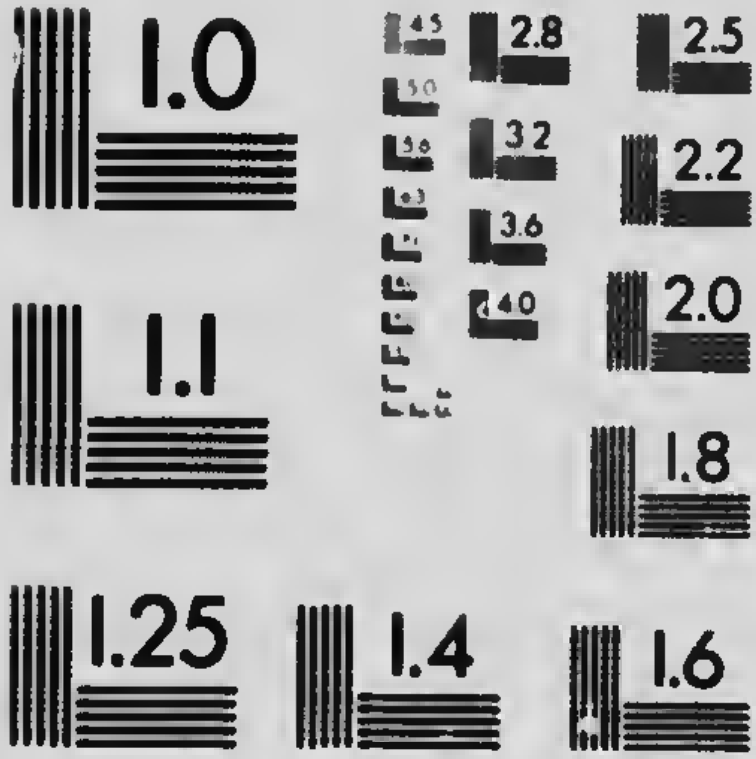

Journal of Pathology and Bacteriology, Vol. XIA.

ON FATTY CHANGES IN THE LIVER, HEART AND KIDNEY.

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In a paper by Hartley and Mavrogordato,[2] attention was first called to the fact that when the amount of fat in the liver is increased the amount of unsaturated acids in that fat as determined by their iodine value is diminished.

This fact has been repeatedly confirmed and holds for other species besides man; when the liver contains what may be regarded as a normal amount of fat, yielding fatty acids after saponification amounting to less or little more than 3 per cent. of the weight of the fresh tissue, then the iodine value of these acids will be about 135, whereas when more is present this value is lower, till in the highest degrees of fatty change, when the fatty acids obtained may amount to 20 per cent. of the fresh weight, the iodine value is almost as low as that of the acids obtained on saponifying adipose tissue. This, in conjunction with certain other facts, gave rise to the following comment:—"It is difficult to see how this is to be explained except by supposing that when there is an excessive amount of fat in the liver it is because an excessive amount of the stored fat of the body has been brought to the liver. And the inference comes ready to hand that a normal liver too has fat brought to it composed largely of saturated acids, but being normal it is able to deal with this fat, converting the saturated acids into less saturated ones".

In the same place reference is made to the case of the heart and kidney, which are also liable to fatty changes, but in which sufficient determinations of this nature had not been made, in order to say whether in them too a similar relationship holds between the amount of fat and of unsaturated acid, though it was already clear that variations on the scale upon which they are found in the liver did not occur in them.

[1] Received May 8, 1911.

[2] *Journ. Path. and Bact.*, Cambridge, 1903, vol. vii, p. 374.

[3] Harvey Lecture on the "Functions of the Liver in relation to the Metabolism of Fat," by J. B. Leathes, *Lancet*, London, February 27, 1909.

The fatty acids obtained from the normal [illegible] and kidney, like those obtained from the normal liver, differ f[illegible] those in the fat of connective tissue in that they consist largely of acids more unsaturated than oleic acid; their iodine value is 135 or more, while that of the acids of adipose tissue is in man about 65, and that of oleic acid is 90. If an organ, therefore, becomes fatty because of an access of connective-tissue fat, the iodine value may be expected to fall in proportion to the amount of connective-tissue fat imported.

In a considerable number of cases, mostly from the Toronto General Hospital, the liver, heart, and kidneys were examined in the same way. Weighed portions freed from connective tissue were heated with potash till liquefied, alcohol added, and the heating continued for half an hour; the fatty acids were precipitated from the soap solution by sulphuric acid, and taken up in a measured quantity of petroleum ether of which a fraction was evaporated, and the residue weighed and taken for the determination of its iodine value by the method of Wijs.[1]

The results have been grouped in four tables. In the first two the cases are arranged in order of the amount of fat found in the liver; in the others, in order of the amount found in the heart and kidney respectively. In each table the group which contained the smallest amount of fat was taken as a standard, together with the average iodine value for this group. And using this standard a curve was constructed for each organ with percentage of fat represented in the abscisse, and iodine values in the ordinates, so as to show the iodine value that would correspond to any percentage of fat on the supposition that any additional amount of fat found in such an organ was imported connective-tissue fat. In the cases of the liver, for instance, there were eleven cases averaging 2·8 per cent., with the iodine value 136. Taking these values as the standard for this organ, then if an equal quantity of connective-tissue fat with the iodine value 65 were imported, we should have 5·6 per cent., with the iodine value 100·5; if double the amount, then 8·4 per cent., with the iodine value 89, and so on. The curve so obtained is drawn in a continuous line in Fig. 1. It therefore represents the conditions that would obtain if importation of connective-tissue fat were the only factor in the fatty change.

The average observed values for the different groups in Table I., with their average iodine values, are shown in the diagram as points surrounded by circles. It is clear that the correspondence between the observed values and the curve is so close that the importation of connective-tissue fat or, what amounts to the same on ordinary diets, of fat absorbed from the intestine, seems to be the main factor

[1] The details of the method and precautions taken were those prescribed in Longmans' biochemical monograph on The Fats, by J. B. Leathes, 1910. Cholesterol, when it was estimated, was estimated in a separate portion; all the figures used in this paper refer to the extract composed of fatty acids mixed with from 10 to 15 per cent. of cholesterol.

determining fatty change in the liver. But it is to be noticed that as the percentage increases up to 6 per cent., or a little more than double the standard amount of fat the observed values tend to be above the curve, but with three times the standard amount or more than that they tend to be below the curve. If the function of the liver is, as the articles referred to above contend, to desaturate fatty acids, then it would appear that this function is stimulated by amounts of fat up to about double the standard amount, increasingly embarrassed by amounts larger than that.

In Table II. the results of the examination of the organs of a few infants and fœtuses are given separately; the figures for the

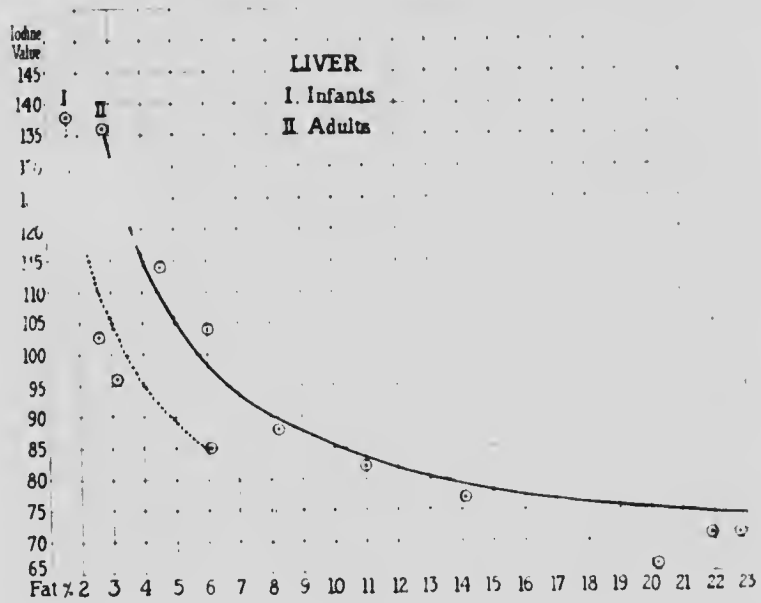

FIG. 1.

amount of fat in the liver appear to be lower than in adults, and accordingly, though the data are obviously too few in number, they have been treated separately and referred to the dotted curve in Fig. 1, the standard for which is the mean of the two cases where the iodine value was about the same as the standard for adults, and which also represents the conditions that would be required on the supposition that any access of fat above the standard amount would be connective-tissue fat with the same iodine value as in adults. The observed values follow the course of the theoretical curve sufficiently closely to justify the expectation that with a larger number of data the correspondence with that curve would be as close as in the case of the adult livers.

In the case of the heart and kidney the first point to be noted

appears in Table I. The cases, grouped there in order according to the amount of fat in the liver, and exhibiting a gradual increase in iodine value from group to group as the amount of fat in the liver approaches the standard value, show no such orderly sequence in the other organs in these respects. The largest average amount of fat in the heart, for instance, occurs in the fifth group, and the next largest in the sixth and seventh, and the average iodine value of the fatty acids from the heart in the third group of cases is practically the same as in the last group; and so too with the kidney, so that it is clear that the condition of the fat in the liver is not what determines the condition of fat in these organs. If they normally take up fat that has been desaturated in the liver, when fat is accumulating in the liver, they do not appear to take up, because that is so, the unaltered fat from the blood; at least such fat is not necessarily found in them in increased amounts. A liver in which the unaltered fat is accumulating may nevertheless be forwarding a normal amount of normally desaturated fat. The accumulation in the liver is not necessarily caused only by failure of the liver to do its work; it may be due to excessive activity in the mobilisation of fat from the storage depots, and to the fact that the liver does not send out the fat it has received till it has been desaturated. But when the figures obtained for the heart and kidney are arranged, as in Tables III. and IV., in groups in order of the amount of fat contained in these organs severally, it is observed that here too the average iodine value for the groups increases as the amount of fat approaches that found in the group containing least fat. So that there is a tendency for the fat in these organs also, when they contain more than usual, to approach in some degree to the type of connective-tissue fat.

When, however, curves are constructed, as has been done in Fig. 2, similar to the curve for the liver in Fig. 1, taking as standard value the average percentage and iodine values observed in the group with the smallest amount of fat, and representing the conditions that would obtain if all fat above that amount were imported connective-tissue fat with the iodine value 65, the average observed values are all found to lie above these curves: in other words, the iodine value does not sink, as it does in the liver as much as it would if all the additional fat were imported direct from the connective tissues. The discrepancy between the observed values and the values calculated on that basis increases as the amount of fat increases. The fatty changes in these organs therefore do not admit of the simple explanation that is so clearly indicated in the case of the liver, that all additional fat is imported from the connective tissues. Some of it may be, but the more fat the organ contains the smaller is the proportion of the additional fat that is of that nature.

Two ideas with regard to the fatty changes in heart and kidney are compatible with what is known: one is that an organ such as the

heart, and probably the kidney, in which fat is oxidised to supply energy, may when diseased lose this power, and in that case become encumbered with a supply of the material that it has lost the power of burning up. If there was a tendency for such fat lying idle to revert to the saturated connective-tissue type, then a condition would result similar to that which the figures reveal.

The other is that the complex fatty substances containing phosphorus degenerate in a diseased organ as they do in a divided nerve. If the importation of desaturated fat from the liver to replace

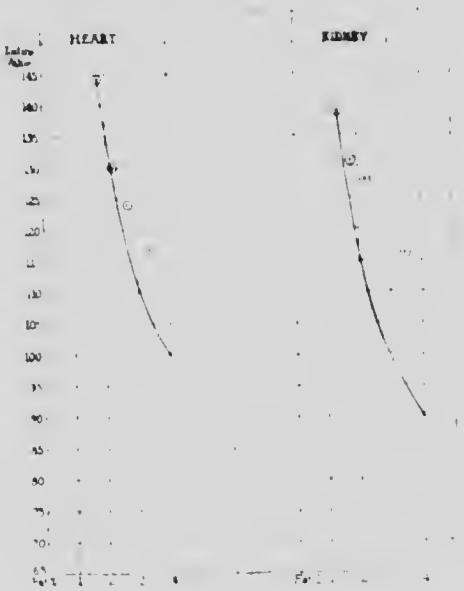

FIG. 2.

the degenerated fat went on as usual, the amount of fat would increase in the organ, and with a certain amount of reversion of the degeneration products to fat of the saturated type, then, too, a condition would be established similar to that observed.

The two points that the figures obtained seem to make certain are (1) that the accumulation of fat in the liver does not determine the condition of the heart or kidney: (2) that while in the liver fatty change is certainly an accumulation of connective-tissue fat, in the heart and kidney some other factor determines, or at least co-operates in determining, the change.

The histological protocols were all checked by Professor J. J. Mackenzie, to whom I am much indebted for this assistance. The rest of the work was carried out under the direction of Professor J. B. Leathes.

[TABLES

TABLE I.—*Cases (Adult) grouped according to Amount of Fat in Liver.*

	Case No.	Diagnosis.	Liver.		Heart.		Kidney.	
			Per cent.	Iodine Value.	Per cent.	Iodine Value.	Per cent.	Iodine Value.
(A) More than 20 per cent	10	Alcoholism	21·80	71	2·97	128	2·54	126
	A1)	Tuberculosis	22·80	71		...		
	(A2	HCl poisoning	20·20	66		...		
(B) More than 12 per cent., less than 16 per cent.	35	Pneumonia	15·11	76	1·60	133	1·32	137
	23	Tuberculosis	12·81	78	2·80	118	2·11	119
		Average .	**14·11**	**77**	**2·20**	**126**	**2·17**	**128**
(C) More than 10 per cent., less than 12 per cent.	30	Addison	11·77	83	2·04	121	3·25	126
	7	Coroner's Case	11·19	84	1·89	141	1·70	137
	24	Chronic pancreatitis	10·61	79	2·09	141	2·27	129
	29	Puerperal sepsis	10·31	81	1·94	147	1·81	137
		Average .	**10·97**	**82**	**1·99**	**138**	**2·27**	**132**
(D) More than 7·5 per cent.; less than 10 per cent.	31	Pneumonia	8·31	94	1·86	152	1·92	123
	8	...	8·17	87	1·99	131	1·79	130
	41	Cholecystitis	7·83	85	3·35	119		
	(A3)	Acute pancreatitis	8·80	86				
	(A1)	Haem. pancreatitis	8·54	86				
	A5)	Acute yellow atrophy	8·10	88				
		Average . .	**8·29**	**88**	**2·40**	**134**	**1·86**	**127**
(E) More than 5 per cent.; less than 7·5 per cent.	39	Malign. endocarditis	6·66	100	2·59	133	2·40	117
	25	Typhoid	6·37	105	1·77	155	1·68	141
	36	Diabetes; lipaemia	5·93	104	2·36	132	3·72	105
	3	Pernicious anaemia	5·69	107	3·77	109	1·55	132
	(A6)	Tuberculous meningitis	5·67	103				
		Average . .	**6·06**	**104**	**2·62**	**132**	**2·34**	**124**

Table I.—continued

	Case No.	Diagnosis	Liver. Per cent.	Liver. Iodine Value.	Heart. Per cent.	Heart. Iodine Value.	Kidney. Per cent.	Kidney. Iodine Value.
(F) More than 4 per cent.; less than 5 per cent.	38	Pernicious anæmia	4·70	109	2·01	135	1·90	[illegible]
	18	Typhoid	4·65	116	1·92	142	1·80	124
	12	Fractured skull	4·42		1·66	144	1·85	136
	2	Pernicious anæmia	4·14	117	2·62	113	1·84	111
		Average . .	**4·51**	**114**	**2·05**	**133**	**1·85**	**125**
(G) More than 3 and less than 4 per cent.	42	Acute peritonitis	3·80	118	2·29	148	2·04	146
	17	Hydrophthalmone poisoning	3·45	126	2·35	120	1·76	127
	21	Toxæmia of pregnancy	3·27	115	1·80	143	1·48	
	22	Carcinoma of pancreas	3·21	131	3·11	112	[illegible]·38	125
	33	Miliary tubercle	3·14	140	1·91	[illegible]	1·69	143
	32	Pneumonia	3·02	131	[illegible]·18	[illegible]18		
		Average .	**3·32**	**127**	**2·37**	**133**	**1·65**	**135**
(H) Less than 3 per cent.	11	Typhoid	2·99	120			1·47	143
	10	Pneumonia	2·98	137	1·88	142	1·84	125
	27	Gastro-enterostomy	2·95	139	1·92	151	1·43	147
	26	Puerperal fever	2·90	133	1·40	141	1·31	137
	1		2·89	148	2·19	127	1·41	139
	6	Pneumonia	2·86	159	2·43	136	2·01	129
	16	,,	2·75	139	2·52	141	1·32	138
	13	Endocarditis	2·74	127	1·82	124	1·67	130
	37	Septicæmia	2·66	131	1·84	156	1·22	142
	19	Tuberculosis	2·54	134	1·57	140	1·84	123
	9	Typhoid	2·46	131	1·35	1·1	1·52	134
		Average .	**2·80**	**136**	**1·92**	**139**	**1·55**	**137**

TABLE II. *Organs obtained from Infants and the Fœtus.*

Case No.	Age	Liver. Per cent.	Liver. Iodine Value.	Heart. Per cent.	Heart. Iodine Value.	Kidney. Per cent.	Kidney. Iodine Value.
4	6 months	6·09	85	2·87	[illegible]	1·73	128
5	2 days	3·18	96	2·19	108	2·41	108
20	7th month fœtus	2·58	103	1·26	132	1·71	138
15	2 days	1·50	143	1·21	162	1·31	142
14	6th month fœtus	1·38	132	1·32	148	1·36	125

TABLE III.—*Cases grouped according to Amount of Fat in the Heart (Adults).*

	Case No.	Per cent. of Fat in Heart.	Iodine Value.	Histological Notes.
A	3	3·77	109	+ + +
	41	3·35	119	+ + + not fatty to N.E.
	17	3·33	120	+ + +
	22	3·11	122	+ + +
Average of 4 cases with more than 3 per cent. in heart.		**3·39**	**118**	
B	10	2·97	128	+ + +
	23	2·80	118	+ + +
	2	2·62	112	+ + +
	39	2·59	133	+ + +
	16	2·52	131	+ +
Average of 5 cases with more than 2·5 per cent. in heart.		**2·70**	**124**	
C	6	2·43	136	+ +
	36	2·36	132	+
	42	2·20	138	+ +
	28	2·20	127	+
	1	2·19	127	No sections.
	32	2·18	118	+ + +
	24	2·09	144	+
	30	2·04	121	+
	38	2·01	135	No sections
Average of 9 cases with more than 2 per cent. in heart.		**2·19**	**131**	
D	8	1·99	131	Brown atrophy.
	29	1·94	147	,, ,,
	18	1·92	142	,, ,,
	27	1·92	151	,, ,,
	7	1·89	141	+
	10	1·88	142	+
	31	1·86	152	+
	37	1·83	156	+ (Tabby cat heart.
	13	1·82	124	+ +
	21	1·80	143	Brown atrophy.
	25	1·77	155	,, ,,
	12	1·66	144	,, ,,
	9	1·65	141	,, ,,
	33	1·61	159	,, ,,
	35	1·60	133	+
	19	1·57	140	+
	26	1·40	141	+
Average of 17 cases with less than 2 per cent. in heart.		**1·76**	**144**	

TABLE IV.—*Cases grouped according to Amount of Fat in Kidney (Adults).*

	Case No.	Per cent. of Fat in Kidney.	Iodine Value.	Histological Notes
A	36	3·72	105	
	30	3·25	126	
Average of 2 cases over 3 per cent.		**3·49**	**116**	
B	40	2·54	120	
	23	2·41	119	
	39	2·40	117	
	24	2·27	129	
	42	2·03	146	
	6	2·01	129	
Average of 6 cases over 2 per cent.		**2·28**	**128**	
C	35	1·92	147	
	31	1·92	123	
	38	1·90	131	No sections.
	12	1·85	135	
	2	1·84	111	
	10	1·84	125	
	19	1·84	123	
	29	1·84	137	No sections.
	18	1·80	123	
	8	1·79	1[illegible]	
	17	1·76	127	
	4	1·70	137	
	25	1·68	141	
	13	1·67	139	
	28	1·60	134	
	33	1·60	143	0
	3	1·55	1[illegible]2	No sections
	9	1·52	1[illegible]4	0
Average of 19 cases over 1·5 per cent.		**1·76**	**131**	
D	11	1·47	1[illegible]	
	1	1·44	139	No sections
	27	1·43	157	
	22	1·38	125	
	37	1·22	142	
	16	1·32	1[illegible]	
	26	1·31	137	
Average of 7 cases under 1·5 per cent.		**1·37**	**139**	

HISTOLOGICAL PROTOCOLS.

Case 1.—No sections were examined.

Case 2 (Pernicious Anæmia).—*Heart*—A large amount of granular fat, patchy in its distribution throughout the heart muscle. In such areas the granules are present in all parts of the cell cytoplasm, 2·62 per cent.; iodine value, 112. *Kidney*—A moderate amount of fat present in the epithelium lining the tubules, most marked in the straight tubules, 1·84 per cent.; iodine value, 111. *Liver*—Moderate amount of fat; fine granular forms distributed throughout the cells of the lobules, with larger globules located about the periphery of the lobules. 4·14 per cent.; iodine value, 117.

Case 3 (Pernicious Anæmia).—*Heart*—Fat unevenly distributed, and where it is present the cells are markedly enlarged, 3·77 per cent.; iodine value, 109. *Kidney*—1·55 per cent.; iodine value, 132. *Liver*—5·69 per cent.; iodine value, 107.

Case 4 (Anæmia in a Child).—*Heart*—Shows a large amount of fat, fairly even in its distribution, 2·87 per cent.; iodine value, 97. *Kidney*—A small amount of fat quite irregular in its location, 1·73 per cent.; iodine value, 128. *Liver*—A large amount of fat present for the most part in the form of large globules, which in many areas extend throughout the whole lobule to the intra-lobular veins, 6·09 per cent.; iodine value, 85.

Case 5 (Infarct with Abscess in Thymus Gland).—*Heart*—Showed no fat whatever, 2·19 per cent.; iodine value, 108. *Kidney*—Small amount of fat in local areas, 2·41 per cent.; iodine value, 108. *Liver*—3·18 per cent.; iodine value, 95.

Case 6 (Pneumonia).—*Heart*—A moderate amount of fine granular fat, also marked brown atrophy, 2·43 per cent.; iodine value, 136. *Kidney*—2·01 per cent.; iodine value, 129. *Liver*—Shows a moderate amount of fat, 2·86 per cent.; iodine value, 159.

Case 7 (Cause of Death Unknown).—*Heart*—Very small amount of fine droplet fat, with much brown atrophy, 1·89 per cent.; iodine value, 141. *Kidney*—Moderate amount of fatty changes, somewhat patchy in distribution, 1·70 per cent.; iodine value, 137. *Liver*—A very large amount of fat, both finely granular and large globular forms, extending irregularly throughout the whole lobule in some areas: 11·19 per cent.; iodine value, 84.

Case 8 (Lobar Pneumonia).—*Heart*—No fat present, but great majority of the cells show some brown atrophy, 1·99 per cent.; iodine value, 131. *Kidney*—Very small amount of demonstrable fat, 1·79 per cent.; iodine value, 130. *Liver*—Abundance of fat, fine granules throughout the cells of the lobules, with large droplets in the cells at the periphery of the lobule, 8·18 per cent.; iodine value, 87.

Case 9 (Typhoid Fever).—*Heart*—Shows no fat, but small amount of brown atrophy, 1·65 per cent.; iodine value, 141. *Kidney*—Very small amount of fat, 1·52 per cent.; iodine value, 134. *Liver*—Small amount of finely granular fat, 2·46 per cent.; iodine value, 131.

Case 10 (Lobar Pneumonia).—*Heart*—Small amount of fine droplet fat in focal areas, and much brown atrophy, 1·88 per cent.; iodine value, 142.

Kidney—Moderate amount of fat present, particularly in the straight tubules, 1·84 per cent.; iodine value, 125. *Liver*—Small amount of fine granular fat centrally located in the lobule, 2·98 per cent.; iodine value, 137.

Case 11 (Typhoid Fever).—*Kidney*—Small amount of fat in focal areas, 1·47 per cent.; iodine value, 133. *Liver*—Small amount of fine granular fat, 2·99 per cent.; iodine value, 120.

Case 12 (Fractured Cranium).—*Heart*—No visible fat, but marked brown atrophy, 1·66 per cent.; iodine value, 144. *Kidney*—Small amount of fat, 1·85 per cent.; iodine value, 135. *Liver*—Quite a moderate amount of fat, 4·49 per cent.

Case 13 (Malignant Endocarditis).—*Heart*—Small amount of fine droplet fat, 1·82 per cent.; iodine value, 124. *Kidney*—Small amount of fine droplet fat, 1·67 per cent.; iodine value, 130. *Liver*—Moderate amount of fat centrally located in the lobules, 2·74 per cent.; iodine value, 127.

Case 14 (Fœtus, Six Months).—*Heart*—Moderate amount of fine granular fat evenly distributed throughout the cells, 1·32 per cent.; iodine value, 148. *Kidney*—No demonstrable fat, 1·36 per cent.; iodine value, 125. *Liver*—Moderate amount of fat present, 1·38 per cent.; iodine value, 132.

Case 15 (Infant).—*Heart*—No demonstrable fat, 1·21 per cent.; iodine value, 162. *Kidney*—No demonstrable fat, 1·31 per cent.; iodine value, 142. *Liver*—Few granules of fat present, 1·90 per cent.; iodine value, 113.

Case 16 (Pneumonia).—*Heart*—Occasional fibres show large amount of fat, though, on the whole, not much fat is seen, 2·52 per cent.; iodine value, 131. *Kidney*—Very small amount of fat, 1·32 per cent.; iodine value, 138. *Liver*—2·75 per cent.; iodine value, 139.

Case 17 (Hydroquinone Poisoning).—*Heart*—Very large amount of fat, 3·3 per cent.; iodine value, 129. *Kidney*—Small amount of fat, 1·76 per cent.; iodine value, 127. *Liver*—Moderate amount of fat, centrally located in the lobules, 3·45 per cent.; iodine value, 125.

Case 18 (Typhoid Fever).—*Heart*—No evidence of fat, but a large amount of brown atrophy, 1·92 per cent.; iodine value, 142. *Kidney*—Moderate amount of fat present, 1·80 per cent.; iodine value, 124. *Liver*—Considerable amount of fat present in both fine granules and larger droplets, 4·65 per cent.; iodine value, 116.

Case 19 (Tuberculosis, Pulmonary). *Heart*—Small amount of fine droplet fat, uneven in its distribution, 1·57 per cent.; iodine value, 140. *Kidney*—Very small areas of fine granular fat, 1·84 per cent.; iodine value, 123. *Liver*—Very small amount of fine granular fat, 2·54 per cent.; iodine value, 134.

Case 20 (Fœtus, Seven Months).—*Heart*—1·26 per cent.; iodine value, 132. *Kidney*—Very small amount of fat, 1·71 per cent.; iodine value, 138. *Liver*—Moderate amount of fat, patchy in its distribution, 2·58 per cent.; iodine value, 103.

Case 21 (Toxæmia of Pregnancy).—*Heart*—No visible fat, but considerable brown atrophy, 1·80 per cent.; iodine value, 113. *Kidney*—Small amount of fat present, 1·48 per cent. *Liver*—Moderate amount of small granular fat, 3·27 per cent.; iodine value, 115.

Case 22 (Carcinoma of the Pancreas).—*Heart*—Large amount of fat, droplets rather large, 3·11 per cent.; iodine value, 122. *Kidney*—1·38 per cent.: iodine value, 125. *Liver*—Moderate amount of fat in lobules and in the carcinomatous areas, 3·21 per cent.; iodine value, 131.

Case 23 (Tuberculosis).—*Heart*—Large amount of fat, 2·8 per cent.; iodine value, 118. *Kidney*—Very small amount of fat, 2·41 per cent.; iodine value, 119. *Liver*—Very large amount of fat, 12·81 per cent.: iodine value, 78.

Case 24 (Pancreatitis, Chronic).—*Heart*—Very few fat granules, but considerable brown atrophy, 2·09 per cent.: iodine value, 144. *Kidney*—Moderate amount of fatty change, 2·27 per cent.; iodine value, 129. *Liver*—Very large amount of fat, 10·64 per cent.: iodine value, 79.

Case 25 (Typhoid with Orbital Cellulitis and Meningitis).—*Heart*—No demonstrable fat, but moderate degree of brown atrophy, 1·77 per cent.: iodine value, 155. *Kidney*—Very small amount of fat present, 1·68 per cent.; iodine value, 141. *Liver*—Large amount of fat, 6·37 per cent.; iodine value, 105.

Case 26 (Puerperal Septicæmia).—*Heart*—Small amount of fine droplet fat and some brown atrophy, 1·40 per cent.: iodine value, 141. *Kidney*—Small amount of fatty change, 1·31 per cent.; iodine value, 137. *Liver*—Small amount of fat demonstrable, 2·90 per cent.: iodine value, 133.

Case 27 (Chronic Alcoholic, Death following Gastro-enterostomy). *Heart*—No visible fat, but large amount of brown atrophy, 1·92 per cent.; iodine value, 151. *Kidney*—Small amount of fat, 1·43 per cent.; iodine value, 157. *Liver*—Moderate amount of fat, for the most part in the cells about the periphery of the lobules, 2·95 per cent.; iodine value, 139.

Case 28 (Tuberculosis).—*Heart*—Small amount of fat, patchy in its distribution, 2·2 per cent.: iodine value, 127. *Kidney*—Small amount of fat present, 1·6 per cent.: iodine value, 134.

Case 29 (Pneumonia).—*Heart*—No visible fat, 1·94 per cent.; iodine value, 147. *Kidney*—1·84 per cent.: iodine value, 137. *Liver*—Abundant fat present, 10·31 per cent.: iodine value, 81.

Case 30 (Addison's Disease).—*Heart*—Very small amount of fat, 2·04 per cent.: iodine value, 121. *Kidney*—Moderate amount of fat, 3·25 per cent.: iodine value, 126. *Liver*—Very abundant fatty change, 11·75 per cent.: iodine value, 83.

Case 31 (Lobar Pneumonia, Meningitis) *Heart*—No visible fat, but considerable brown atrophy, 1·86 per cent.: iodine value, 152. *Kidney*—Moderate amount of fat, 1·92 per cent.: iodine value, 123. *Liver*—Abundant fat present, 8·31 per cent.: iodine value, 94.

Case 32 (Miliary Tuberculosis).—*Heart*—Moderate amount of fat present, 2·18 per cent.; iodine value, 118. *Liver*—Small amount of demonstrable fat, 3·02 per cent.: iodine value, 131.

Case 33 (Pneumonia).—*Heart*—No demonstrable fat, some brown atrophy, 1·61 per cent.; iodine value, 159. *Kidney*—No fat present, 1·60 per cent.; iodine value, 143. *Liver*—Small amount of fat present, 3·14 per cent.; iodine value, 140.

Case 34 (Gastric Carcinoma).—*Heart*—No demonstrable fat, but considerable brown atrophy, 2·12 per cent.; iodine value, 148. *Kidney*—Moderate amount of fat, 1·93 per cent.; iodine value, 131. *Liver*—Moderate amount of fat, 4·75 per cent.; iodine value, 85.

Case 35 (Lobar Pneumonia).—*Heart*—Marked brown atrophy, but no fat, 1·60 per cent.; iodine value, 133. *Kidney*—Small amount of fat, 1·92 per cent.; iodine value, 137. *Liver*—Very large amount of fat, 15·41 per cent.; iodine value, 76.

Case 36 (Diabetes with Lipæmia).—*Heart*—Shows a moderate amount of fat, some of which is intracellular, but the greater portion is present in the intercellular capillaries, 2·36 per cent.; iodine value, 132. *Kidney*—A large amount of fat present in the epithelium lining the tubules, and in the blood vessels and capillaries of the kidney, 3·72 per cent.; iodine value, 105. *Liver*—Shows quite a large amount of fat, there is some fine granular fat within the cells, but most of the fat is present in the intercellular spaces and so marking out the cellular structure of the organ, 5·93 per cent.; iodine value, 104.

Case 37 (Septicæmia).—*Heart*—Small amount of fat, but to naked eye typical "tabby-cat" markings, 1·83 per cent.; iodine value, 156. *Kidney*—Very small amount of fat, 1·22 per cent.; iodine value, 142. *Liver*—Small quantity of fat, 2·66 per cent.; iodine value, 134.

Case 38 (Pernicious Anæmia).—No sections.

Case 39 (Malignant Endocarditis).—*Heart*—Large amount of fine granular fat, 2·59 per cent.; iodine value, 133. *Kidney*—Large amount of fat, 2·40 per cent.; iodine value, 117. *Liver*—Abundant fatty changes, 5·66 per cent.; iodine value, 100.

Case 40 (Chronic Alcoholism).—*Heart*—Large amount of fat, 2·97 per cent.; iodine value, 128. *Kidney*—Large amount of fat, 2·54 per cent.; iodine value, 126. *Liver*—Very abundant fatty infiltration, 21·9 per cent.; iodine value, 70·9.

Case 41 (Cholecystenterostomy).—*Heart*—Very large amount of fat, 3·36 per cent.; iodine value, 119·3. *Liver*—Abundant infiltration of fat, 7·83 per cent.; iodine value, 85.

Case 42 (Septic Peritonitis).—*Heart*—Fine granular fat in all the cells; 2·19 per cent.; iodine value, 138. *Kidney*—Small amount of fat, 2·03 per cent.; iodine value, 146. *Liver*—Moderate amount of fat, 3·80 per cent.; iodine value, 118.