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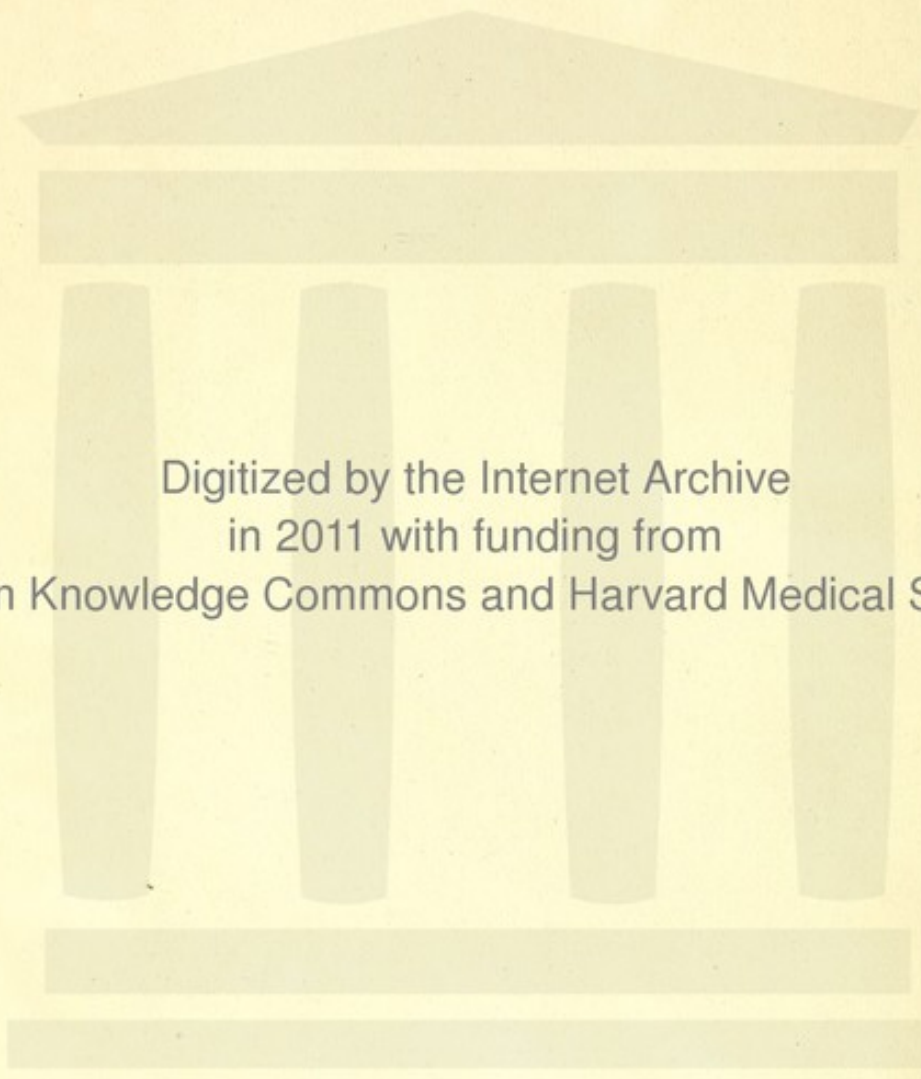


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ON

THE WEIGHT AND DIMENSIONS

OF

THE HEART,

IN HEALTH AND DISEASE.

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ON THE

# WEIGHT AND DIMENSIONS OF THE HEART

IN

## HEALTH AND DISEASE.

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THE following paper contains a series of observations, with calculations based upon them, intended to illustrate the weight and dimensions of the heart in health, and the changes which it undergoes in different forms of disease.

The observations have all been collected by myself within the last few years; some have already been published in connection with a series of tables of the weight of the brain,<sup>1</sup> but most of them have not previously appeared in print, and all the weights of the diseased heart and the measurements, are now first collected and analyzed. In order to present the facts in a more complete form, and to furnish the means of ready comparison between the results here arrived at and the data from which they are deduced, I have preferred to give the whole of the observations together, rather than to refer to the former papers for those previously published.

The tables include 198 observations of the weights of organs regarded as healthy, and 150 observations of the weights of hearts presenting either primary or secondary disease. The measurements are of 42 healthy and 45 diseased organs. The whole series is a careful selection from a larger number of observations, of which those only are given which are regarded as accurate and complete.

The mode in which the observations were made is as follows:—The heart having been removed from the body, and the aorta and pulmonary artery cut across about an inch above their origin, the left ventricle was laid open by an incision commencing near the aortic orifice, and continued down to the apex, and thence through the posterior wall, so as fully to expose the cavity, without interfering with the attachments either of the aortic or semi-lunar valves. The

<sup>1</sup> Monthly Journal of Medical Science, vol. vii. (New Series, vol. i.) 1846.



right ventricle was exposed by a similar incision extending from near the origin of the pulmonary artery to the apex, and the

## WEIGHTS AND DIMENSIONS

No.	Age.	Sex.	Weight of Body.			Girth of Right Ventricle.	Girth of Left Ventricle.	Length of Cavity of Right Ventricle.	Length of Cavity of Left Ventricle.	Thickness of Walls of Right Ventricle.		
			lb.	oz.	dr.	lines	lines	lines	lines	Base.	Mid-point.	Apex.
1	7 days	F.	7	0	13	25	19			—	2	—
2	10 months	M.		1	10	29	25			—	1	—
3	1 year	F.	15	2	0	34	32	22	19	2	2	1½
4	3 years	F.	22	1	10	35	35	21	21	—	1	—
5	3	M.		2	15	35	35			—	1	—
6	4½	M.		2	9	36	30	25	22	1½	1½	1
7	8	F.	56	5	1	42	36	36	30	1	2	1
8	8	F.	24	3	0	36	30	27	24	1	1½	1
9	11	M.	43	4	6	38	37	34	28	2	2	1
10	13	F.	46¾	6	2					1½	2	1½
11	18	F.		7	15	52	48	34	31	1¾	2	1
12	20	M.	97	11	0	49	45	48	39	2	2	1½
13	24	M.		8	8	50	46	40	34	1½	1½	1½
14	24	M.		9	1½	60	60	34	32	2	2	1½
15	24	M.		9	0	60	54	42	40	2	1½	1
16	25	M.		8	8	60	38	35	32	2	2	1
17	26	M.	101	8	11	54	48	45	36		1½	
18	27	M.	120	11	12	52	52	45	42	2	2½	1½
19	30	M.		8	15½			40	36	1¼	2	1
20	31	M.		9	4	48	53	46	37	2	2	2
21	37	M.		6	4½	50	42	36	36	2	2	1¼
22	66	M.		10	8	60	46	45	37	2	2	1
23	20	F.		7	4	49	38	40	32	2	2	1
24	24	F.		10	11	60	48	48	42	1½	3	1½
25	47	F.		10	3			42	36	3½	2½	2
26	60	F.	87	11	0	52	40	42	36	2	2	1
27	66	F.	70	7	0	48	42	42	27	—	1½	—
28	14	M.		4	10	41	37	33	34	1½	2	¾
29	23	M.	105	6	9½	54	44	42	36	2	2¼	2
30	25	M.		11	0			50	44	2	2	2
31	35	M.	88	8	0	58	48	44	36	1½	2	1½
32	38	M.		11	0	66	50	51	45	2	2½	1½
33	19	F.	133	8	10	54	48	52	42	2	2½	1
34	21	F.		9	8	60	60	48	44	1½	1½	1½
35	21	F.		7	13	58	48	42	36	2	1½	1
36	20	F.	95	9	5	60	50	46	41	2	2½	1
37	22	F.	122	9	10	72	48	48	39	2	1½	1
38	28	F.		8	8	54	48	48	36	1½	2½	1½
39	37	F.	86	7	1	60	48	42	36	1	1½	½
40	50	F.		9	4	60	52	48	41	2½	2½	1
41	56	F.		10	8					2½	3	2½
42	64	F.		7	0			34	36	2	2	2



auricles were laid open transversely. The organ was then deprived of coagulum, washed, wiped, and weighed.

## OF HEALTHY HEARTS.

Thickness of Walls of Left Ventricle.			Thickness of Septum.	Circumference of Apertures.				Cause of Death.
Base.	Mid-point.	Apex.		Tricuspid.	Pulmonic.	Mitral.	Aortic.	
lines.	lines.	lines.	lines.	lines.	lines.	lines.	lines.	
—	2	—		13	13	13	13	[pneumonia
3	3	1½		22	19	22	19	Acute hydrocephalus and
3	3	2	4	28	22	25	17½	Bronchial phthisis.
3½	4	1½	3	26	21	25	18	Burn, 4 hours.
3	4	2		31	24	28	22	Diseased kidneys and dropsy; empyema.
3	4	1½		36	25	30	20	Phthisis, 4 valves to pulmonary orifice.
3	4	2		33	30	33	27	Burn of abdomen.
3½	3½	2		36	27	30	24	Abscess of liver; diseased mesenteric glands.
5	5	2		39	33	36	24	Fractured skull.
4½	5	1½		42	36	42	30	Fever; enlarged spleen.
7	7	3	6	48	42	45	30	Phthisis & morbus renum.
4	7	2	6	43	29	37	26	Phthisis.
5	6	2½	6	45	39	42	36	Meningitis.
5	6	3	5	60	42	48	39	Ascites and diseased liver.
6	5	2	6	60	34	42	31	Fever; foramen ovale not entirely closed.
4	6	2	6	54	45	51	42	Disd. kidneys and bladder.
5	6	3		60	42	48	36	Ulceration of intestines.
5	7	2	7	50	32	38	28	Fever, cirrhosis hepatis.
5½	3½	2	3½	51	45	48	36	Abscess of brain.
6	7	2½	6½	54	48	51	42	Phthisis.
6	5	2½	5	51	39	48	36	Phthisis.
5	7	2¼	6	51	39	39	36	Fever.
6	8	2	4	42	33	37	29	Variola.
3½	5	2		60	45	48	36	Ac. capillary bronchitis.
7	5	2½		54	39	45	30	Ac. asthenic bronchitis supervening on chronic
4	7	2		40	34	42	39	Bronchitis.
6	7	2		51	42	48	33	Phthisis.
4	5	3	4	42	36	39	30	Fever. [morbus renum.
5	6	3½	6	57	39	42	33	Peritonitis; waxy liver;
5	6	3	6	54	45	45	39	Cholera.
4½	5	3			36		32	Hemiplegia.
5	5½	2	5	62	45	54	39	Secondary abscesses in
4	4	3	5½	60	39	48	33	Fever. [lungs and liver.
4½	6	3		57	39	51	33	Cholera.
6	5	3	5	45	39	42	36	Chron. periton.; meningit.
5	5	2½	3½	51	39	39	33	Phthisis.
5	6	2½	6	51	42	45	36	Cholera.
5	6	3	5	57	42	54	36	Cholera.
4	5	2½	4	54	39	45	33	Cholera.
4	6	3	5½	57	36	45	33	Erysipelas.
6	8	2		45	39	45	30	Chronic bronchitis.
5	5	3		54	42	45	36	Morbus renum.



The measurement of the girth of the heart externally was taken with a piece of tape or string, from the line of the septum in front to the corresponding situation behind. The capacity of the orifices was ascertained by the passage of graduated balls, numbered from 1 to 15, and measuring from 21 to 63 French lines—each ball being 3 French lines more in circumference than that of the

## WEIGHT OF HEALTHY HEARTS.—MALES.

No.	Age.	Weight of		Cause of Death.
		Body.	Heart.	
		lb.	oz. dr.	
43	6 mths.		0 13½	
44	2 „	24	2 10	Burn, 21 days.
45	2 yrs.	31½	2 12	Burn, 6 hours.
46	4		4 4	Burn, 12 hours.
47	5	21	3 0	Coma, succeeding cholera.
48	8	48	6 4	Scarlatina.
49	10	45	4 4	Cholera.
50	11	42	8 8	Typhoid fever.
51	11		5 2	Typhoid fever.
52	11	38	4 0	Chorea.
53	11		6 0	Phthisis.
54	14		9 0	Amputation of toe ; morbus renum.
55	14		6 8	Typhoid fever.
56	15	88	8 0	Laceration of internal organs from injury.
57	15		6 0	Phthisis ; copious hæmoptysis.
58	16	47	5 8	Phthisis.
59	16		7 0	Bronchial phthisis.
60	16		6 8	Typhoid fever.
61	17		8 8	Typhoid fever.
62	19		11 0	Typhoid fever.
63	20	100	10 0	Diphtheritis.
64	21		8 8	Strumous pyelitis.
65	21	106	9 8	Phthisis.
66	22	127	8 0	Phthisis.
67	24		8 0	Phthisis.
68	24		10 0	Fever.
69	24	90	7 8	Phthisis.
70	24		10 4	Phthisis.
71	25	103	10 0	Phthisis.
72	25	125	10 8	Fever ; white spot on pericardium.
73	25		9 0	Fever.
74	26		8 12	Lumbar abscess.
75	27	145	9 0	Phthisis.
76	27		11 4	Variola.
77	28	108	8 8	Fever.
78	28	97	9 8	Phthisis ; softening of brain.
79	28	108	10 0	Fever.
80	28	97	7 8	Morbus renum.
81	29		11 0	Morbus renum,
82	29		11 0	Phthisis ; white spot on pericardium.
83	32		11 8	Double pneumonia.
84	32		11 8	Morbus renum.
85	33		10 8	Ulceration of cartilages of knee.

former number. The capacity of the orifices having been ascertained, and the state of the valves observed, the orifices were laid open, and the length of the ventricular cavities measured from the attachments of the aortic and pulmonic valves to the apex. The thickness of the parietes was then ascertained at three points, near the base, where the walls begin to narrow; at the mid-point between the

## WEIGHTS OF HEALTHY HEARTS—MALES—CONTINUED.

No.	Age.	Weight of			Cause of Death.
		Body.	Heart.		
		lb.	oz.	dr.	
86	33		9	0	Diseased liver.
87	33	99	8	0	Phthisis ; aorta atheromatous.
88	33		11	0	Apoplexy ; aorta atheromatous.
89	35		8	0	Morbus renum.
90	35	100	7	8	Phthisis.
91	35	87	7	4	Morbus renum,
92	35		6	12	Phthisis.
93	35		11	8	Laceration of aorta, from violent muscular exertion.
94	37	112	8	0	Fever, white spots on pericardium.
95	37	90	9	10	Abscess on buttock and secondary deposits.
96	37		9	0	Pneumonia.
97	37	84	9	4	Phthisis.
98	37		9	0	Fever.
99	38		8	8	Fever.
100	38		10	0	Meningitis ; pneumonia.
101	38	100	10	12	Fever, chronic bronchitis.
102	38		8	8	Erysipelas of head.
103	38		11	0	Delirium tremens ; softening of brain.
104	39		6	0	Carcinoma pylori.
105	39		11	0	Phthisis.
106	39		9	12	Phthisis.
107	40		11	0	Phthisis, two valves to aortic orifice.
108	40		11	12	Fever.
109	40		11	8	Cirrhosis hepatis.
110	40	130	11	8	Delirium tremens.
111	40		10	4	Phthisis.
112	41		9	8	Phthisis.
113	42	115	11	12	Pneumonia.
114	42	114	8	8	Phthisis.
115	45	79	9	8	Phthisis.
116	45		10	0	Phthisis.
117	46	90	10	0	Injury ; purulent deposits ; white spot on pericardium.
118	47	129	10	0	Phthisis.
119	50		9	0	Fever.
120	50		9	0	Fever.
121	51		9	12	Pleuropneumonia.
122	52		10	8	Bronchitis ; white spots on pericardium.
123	53	115	10	8	Complicated dislocation of astragalus; white spot on pericardium.
124	53	108	5	0	Cirrhosis hepatis and morbus renum.
125	54	146	11	8	Meningitis and apoplexy.



base and apex ; and near the apex. The septum was cut across about half way between the base and apex, and measured across its centre.

No organs were weighed in which there was an undue proportion of fat on the surface, and none were measured which, whether from disease or post-mortem change, were very flaccid. The weight employed is avoirdupois, and the measure French lines and inches—

## WEIGHTS OF HEALTHY HEARTS—MALES—CONTINUED.

No.	Age.	Weight of			Cause of Death.
		Body.	Heart.		
	Years.	lb.	oz.	dr.	
126	54		9	0	Pleuritis ; peritonitis.
127	55	80	8	8	Tertiary symptoms.
128	55		8	0	Phthisis.
129	56		11	8	Cut throat.
130	56	84	7	0	Phthisis.
131	60	102	11	8	Disease of stomach.
132	60	101	10	0	Fractured ribs ; pneumonia.
133	60	129	11	0	Phthisis ; white spot on pericardium.
134	60		11	8	Phthisis.
135	60		11	0	Chronic dysentery.
136	62	99	10	8	Phthisis.
137	70		11	8	Fever ; white spot on pericardium.

## WEIGHTS OF HEALTHY HEARTS—FEMALES.

138	10 wks.		1	3	
139	1 year				
	and $\frac{3}{4}$ th	13 $\frac{1}{2}$	1	8	Subacute hydrocephalus.
140	5 years	28	2	14	Cholera.
141	6		2	12	Burn, 14 hours.
142	7	32	2	3	Fever.
143	7		3	0	Fever.
144	11	36	3	14	Cholera.
145	17	59	4	8	Phthisis, necrosis.
146	17		7	0	Phthisis.
147	18	113	9	8	Fever.
148	18		10	8	Bronchitis ; phthisis.
149	19		7	12	Typhoid fever.
150	19		8	0	Cholera.
151	20	90	9	0	Phthisis.
152	21	86	5	12	Phthisis.
153	21		10	8	Morbus renum.
154	21	97	10	0	Phthisis.
155	22		10	4	Fever.
156	23	85	6	12	Phthisis.
157	23		8	8	Disease of ear and brain.
158	24		11	0	Acute capillary bronchitis.
159	25	86	9	12	Pneumonia.
160	25		5	8	Phthisis.
161	25	66	8	0	Tertiary syphilis.
162	25	117	9	0	Variola.

the French line being 0·888 of an English inch, and the French inch equal to 1·065 English inch, or rather more than  $\frac{1}{15}$  longer. The French line is equal to 2·25 millimetres, and the millimetre is equal to ·03937 English inches. The French measures were made use of as having been those employed by M. Bizot and some other observers.

## WEIGHTS OF HEALTHY HEARTS—FEMALES—CONTINUED.

No.	Age.	Weight of			Cause of Death.
		Body.	Heart.		
	Years.	lb.	oz.	dr.	
163	26		9	0	Acute phthisis.
164	28	97	9	8	Fever.
165	28		7	4	Morbus renum.
166	28		7	12	Phthisis.
167	28		7	4	Morbus renum.
168	29		9	8	Disease of liver.
169	30		8	8	Pneumonia ; morbus renum.
170	30		10	0	Cholera.
171	31	104½	9	0	Delirium tremens.
172	31	89	9	12	Fever.
173	32	107	9	12	
174	33	84	8	8	Fever.
175	34	88	7	8	Phthisis.
176	34	103	11	0	Phthisis.
177	34	71	6	8	Morbus renum.
178	35	58	5	8	Phthisis.
179	36		8	8	Ac. supervening or chronic bronchitis.
180	36		10	12	Fever.
181	38	79	11	0	Phthisis.
182	39		8	8	Scrofulous abscess of liver.
183	39		10	0	Pleuritis ; morbus renum.
184	39	73	7	7	Phthisis.
185	39	95	9	0	Phthisis ; puerperal mania.
186	39		9	8	Morbus renum.
187	40		9	0	Sudden death during convalescence from fever.
188	40		9	4	Pneumonia ; gangrene of os uteri after fever.
189	40	75	8	0	Relapsing fever.
190	45	109¾	11	0	Phthisis.
191	45	91	8	0	Tubercular peritonitis.
192	47	109	9	12	Morbus renum.
193	50		7	0	Phthisis.
194	51		8	8	Phthisis ; white spot on pericardium.
195	52	74	8	0	Fever.
196	53	101	10	12	Phthisis.
197	56		10	8	Fever.
198	58	66	8	0	Gangrene of leg from obliteration of aorta.



## WEIGHTS AND MEASUREMENTS

No.	Age.	Sex.	Weight of Body.	Weight of Heart.		Girth of Right Ventricle.	Girth of Left Ventricle.	Length of Cavity of Right Ventricle.	Length of Cavity of Left Ventricle.	Thickness of Walls of Right Ventricle.			Thickness of Walls of Left Ventricle.		
										Base Mid-pt. Apex			Base Mid-pt. Apex		
	Yrs.		lb.	oz.	dr.	lines	lines	lines	lines	lines	lines	lines	lines	lines	lines
1	25	F.		9	0	54	40	44	32	4	4	2	4	4	2
2	5	F.		3	12					—	2	—	4	4	2
3	15	M.		10	0	54	42			2	to	5½	3½	to	4½
4	20	M.		12	0	66	42			4	7	3	6	5	3
5	8½	F.		6	8	54	42			4	3	1	5	6	2
6	45	M.	149	17	8	56	58	47	52	2	2	2	6	9	3
7	33	M.		12	8	60	54	42	40	1½	1½	1½	6	6	1½
8	35	M.	78	10	12	54	48	42	36	3	3	2	6	8	2
9	44	M.	127	12	12	54	50	48	40	2	1½	1	5	7	2
10	40	M.		12	8	60	50	48	41	2½	2	1	5½	6	3
11	50	M.		14	0	60	56	48	40	2	2	2	4	7	3
12	65	M.		12	8			36	36	2	2½	1	7	7	2½
13	65	M.	137	12	0	48	39	51	40	2	2	1	6	8	2
14	65	M.		40	12	96	86	62	51	3	2½	2	8	11	3½
15	71	M.		21	0	72	66	48	42	2	3	1½	10	11	2½
16	72	M.		14	0	76	54	51	36	3	4½	1½	6	6	2½
17	78	M.		18	0	54	66	42	36	3	5	2	6	9	4
18	60	F.		14	0	60	60	48	42	2	2	2	5	7	2½
19	62	M.		14	8			36		2	3	1½	8	9	4
20	62	M.		16	0			42	36	—	2½	—	6½	7	3½
21	24	M.		15	8	62	62	50	49	2	1½	½	7½	7½	1¼
22	75	F.		10	12	48	45	40	38	2	2	2	8	8	3
23	33	M.		17	12	54	62	60	48	2	3	2	6	10	3
24	32	M.		16	0			56	42	2	2½	¾	4	7	1½
25	42	M.		16	0	53	63	50	44	1¾	2¼	1	6½	5½	2
26	50	M.		23	0	66	60	66	50	2½	3½	2½	7	7	3

## OF DISEASED HEARTS.

Thickness of Septum.	Circumference of Apertures.				Cause of Death, and Form of Disease.
	Tricuspid.	Pulmonic.	Mitral.	Aortic.	
lines	lines	lines	lines	lines	
11	51	39	45	30	Chronic bronchitis, with deformed spine.
	39		33	25	Abnormal septum in right ventricle.
	39	13	36	33	Abnormal septum in right ventricle ; aorta arising from both ventricles ; pulmonary or contracted.
	45	12	36	30	Great contraction of pulmonary orifice, with open foramen ovale.
	42	36	39	19	Open foramen ovale ; thickening of valves.
	58	48	56	39	Double pneumonia ; no valvular disease.
	60	48	51	39	Plenopneumonia ; some tendency to excavation at apex of left ventricle.
	60	42	48	39	Diseased hip ; malformation by defect of aortic valves, with thickening of valves.
	7	42	35	39	Fever.
	6 $\frac{1}{2}$	54	48	54	Fever and bronchitis ; slight thickening of valves.
10	5	60	48	51	Erysipelas of head ; slight thickening of aortic and mitral valves.
	6	54	48	48	Intussusception ; valves somewhat thickened, and aorta dilated.
	6	57	42	45	Fever, with icterus and hæmorrhage from bowels ; no material valvular disease.
	63	54	60	42	Sudden death ; slight atheromatous degeneration of aortic and mitral valves, and of aorta.
	8	60	42	51	Bronchitis ; thickening of aortic and mitral valves ; dilatation of aorta.
	4	60	45	54	Chronic bronchitis ; atheromatous disease of aorta and pulmonary artery ; thickening of valves.
	60	45	54	39	Scalp wound ; thickening of aortic and mitral valves ; great dilatation of aorta.
	60	39	45	33	Some thickening of aortic valves ; disease and dilatation of aorta ; fatty degeneration.
	57	42	48	33	Contraction of aortic orifice, and thickening of the valves ; rupture of septum ventriculorum.
	54	42	48	36	Mass of bone projecting into the aortic orifice ; valves ossified ; recent pericarditis.
8	57	45	51	42	Apoplexy ; aortic valves much thickened and de- curtated ; atheromatous disease of mitral valves and of aorta.
					Extreme contraction of aortic orifice from malformation and ossification of valves ; death from strangulated hernia.
	60	42	54	30	Injury of aortic valves from violent exertion.
	60	48	60	42	Incompetency of aortic valves, with recent endocarditis and fibro-cartilaginous degeneration of muscular structure.
	60	45	51	36	Extensive disease of aortic valves ; obstruction and incompetency ; aortic disease.
	60	48	54	45	Retroversion and perforation of aortic valves ; some disease of mitral and of aorta.



## WEIGHTS AND MEASUREMENTS

No.	Age.	Sex.	Weight of Body.	Weight of Heart.		Girth of Right Ventricle.	Girth of Left Ventricle.	Length of Cavity of Right Ventricle.	Length of Cavity of Left Ventricle.	Thickness of Walls of Right Ventricle.			Thickness of Walls of Left Ventricle.		
										Base Mid-pt. Apex			Base Mid-pt. Apex		
										lines	lines	lines	lines	lines	lines
27	Yrs. 55	M.	lb.	oz.	dr.	lines	lines	lines	lines	$2\frac{1}{2}$	5	2	10	$5\frac{1}{2}$	1
28	56	M.		15	4	58	55	48	36	—	$3\frac{1}{2}$	—	6	5	$3\frac{1}{2}$
29	57	M.		11	8	44	60	38	38	2	3	1	7	7	$2\frac{1}{2}$
30	46	F.	91	16	0			52	52	2	2	$1\frac{1}{2}$	6	7	3
31	27	F.		8	8	60	48	42	36	2	2	1	4	5	2
32	23	F.		10	8	59	47	44	39	3	2	1	5	5	2
33	39	F.		15	12	75	52	51	42	2	3	$1\frac{1}{2}$	5	5	2
34	40	F.		12	8	66	50	48	42	2	2	1	6	7	3
35	68	F.		12	0	54	48	45	36	2	2	2	5	5	2
36	8	F.		10	8	60	48	36	36	2	2	$1\frac{1}{2}$	5	5	3
37	11	F.		7	8	41	45	33	33	$1\frac{1}{2}$	2	$1\frac{1}{2}$	5	$6\frac{1}{2}$	$2\frac{1}{2}$
38	12	F.		12	0	54	60	36	42	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	5	5	$2\frac{1}{2}$
39	18	F.		13	8	72	54			2	2	1	6	6	3
40	39	F.		22	0					—	4	—	9	11	3
41	63	F.		22	0	55	55	43	42	2	2	$1\frac{1}{2}$	7	10	2
42	37	F.		9	0					$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	4	4	4
43	18	M.		16	0	66	56	57	48	3	$2\frac{1}{2}$	$1\frac{1}{2}$	7	8	4
44	3mo.	F.		1	0	27	24	17	18	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{1}{4}$
45	19 y.	F.		17	8	84	48	53	46	4	4	3	5	6	2
46	75	F.		10	2	60	44	39	39	$2\frac{1}{2}$	3	2	5	8	3

## OF DISEASED HEARTS—CONTINUED.

Thickness of Septum.	Circumference of Apertures.				Cause of Death, and Form of Disease.
	Tricuspid.	Pulmonic.	Mitral.	Aortic.	
lines	lines	lines	lines	lines	
	60	51	60	45	Incompetency from adhesion of valves and dilatation of orifice ; aortic disease.
	54	45	54	39	Incompetency ; recent endocarditis.
9	48	39	42	36	Softening of brain and apoplexy ; old pericarditis ; thickening and incompetency of aortic valves ; dilatation of aorta.
		37		29	Thickening and decurtation, and incompetency of aortic valves ; aorta dilated and diseased.
4	57	39	39	30	Peritonitis, from passage of gall-stones. Pericardium entirely adherent from old attachments ; mitral valve thickened and rigid.
6		29	22	25	Great contraction of aperture, and induration and thickening of mitral valve.
5	54	39		33	Sudden death. Very great contraction of mitral aperture, and induration and thickening of valves.
5	40	30	24	27	Fever. Great contraction of mitral aperture, and some thickening of aortic valves.
	54	36		30	Great contraction of mitral aperture, and induration and thickening of valves.
	36	33	45	30	Free regurgitation through mitral aperture, from dilatation of the orifice ; valves slightly opaque and thick. L. aur. ; $1\frac{1}{2}$ to 2 l. thick.
5	42	30	36	30	Combined aortic and mitral disease, chiefly mitral ; sequence of rheumatism of two years' duration.
	48	33	36	30	Great aortic and mitral disease ; sequence of rheumatic fever 9 years before.
5	42	36	42	27	Thickening and contraction of mitral, with some of aortic aperture and valves ; old pericarditis ; sequence of rheumatism 15 months before.
	51	39		30	Very great contraction of mitral aperture, with thickening of the aortic valves ; aorta atheromatous.
	51	32	43	35	Contraction of mitral aperture ; crescentic thickening of aortic valves ; tricuspid valve thickened ; chronic bronchitis.
	21	34	18	30	Very great contraction of tricuspid and mitral valves ; slight thickening of aortic valves.
7	54	42	45	42	Aortic valves much thickened and incompetent ; mitral valves thickened, adherent and permanently open ; pericardium universally adherent, sequence of rheumatism 4 years before.
3	24	18	21	16	Atelektasis pulmonum.
6	51	8	45		Malformation ; contraction of pulmonic aperture, aorta arising from both ventricles ; posterior wall of right ventricle 7 lines thick.
6	54	34	42	32	Obstruction at aortic orifice, with dilatation of aorta ; valves with vegetations, some ath. of mitral and in aorta ; 5 valves to pulmonary artery.



## WEIGHT OF DISEASED HEARTS—MALES—CONTINUED.

No.	Age.	Weight of		Cause of Death, and kind of Disease.
		Body.	Heart.	
	Years.	lbs.	oz. dr.	
43	14		16 12	Dilatation and hypertrophy of walls of left ventricle, without valvular disease; recent lymph on pericardium.
44	18		28 0	Destruction of aortic valves occasioning incompetency; malformation.
45	18		12 8	Pericarditis; purulent deposits after amputation.
46	22		12 0	Compound fracture.
47	25		12 0	Laceration of walls of heart from injury.
48	22		12 0	Phthisis; some thickening of tricuspid valve; hypertrophy and dilatation of right ventricle.
49	24		14 8	Combined mitral and aortic valvular disease.
50	23		13 0	Pneumonia; hypertrophy of left ventricle, without valvular disease.
51	21		24 0	Incompetency of aortic valves, with thickening of mitral valves.
52	25		12 0	Phthisis.
53	29		14 4	Left ventricle hypertrophied and dilated; aorta dilated.
54	26		15 0	Incompetency of aortic valves, with thickening and opacity of mitral.
55	26		13 0	Delirium tremens; some thickening and opacity of left valves.
56	27		15 0	Fever; chronic bronchitis of left valves and emphysema.
57	29		12 8	Phthisis; no valvular disease.
58	29		14 0	Cholera; great contraction, thickening, and induration of mitral valve.
59	38		21 0	Aneurism of septum of left ventricle, with hypertrophy and dilatation of both ventricles.
60	38		12 0	Phthisis and pneumonia; some opacity of pulmonary valves.
61	39		21 0	Apoplexy; great hypertrophy of left ventricle, but no valvular disease; aorta much dilated and diseased.
62	32		12 8	Phthisis; no valvular disease.
63	33		21 0	Incompetency of aortic valves, from malformation by defect; thickening; morbus renum.
64	36		13 0	Pneumonia; hypertrophy of left ventricle; white spots on pericardium; no valvular disease.
65	38		15 0	Chronic bronchitis and emphysema; no valvular disease.
66	30		24 0	Phthisis, pneumonia; aneurism of transverse arch; no valvular disease.

## WEIGHT OF DISEASED HEARTS—MALES—CONTINUED.

No.	Age.	Weight of		Cause of Death, and kind of Disease.
		Body.	Heart.	
	Years.	Lbs.	oz. dr.	
67	37		14 8	Delirium tremens; slight opacity and thickening of left valves.
68	34		16 0	Fever; no valvular disease.
69	32		14 8	Incompetency of aortic valves; diseased kidneys and spleen.
70	38		19 0	No material valvular disease; dilatation of aorta.
71	38		11 8	Phthisis; aorta dilated and diseased; some thickening of walls of right ventricle.
72	34		20 0	Hypertrophy and dilatation of right ventricle, without valvular disease.
73	30		14 8	Pneumonia; hypertrophy and dilatation of left ventricle, without valvular disease.
74	30		13 8	Chronic bronchitis; no valvular disease.
75	36		23 8	Aortic valves incompetent; some thickening of mitral and diseased aorta.
76	36		17 8	Mitral valvular disease; some thickening of aortic valves; hypertrophy, and dilatation both of right and left ventricles; hemiplegia.
77	33		14 0	Morbus renum; recent pericarditis; no material valvular disease.
78	34		22 4	Incompetency of aortic valves; slight thickening of mitral.
79	36		12 0	Fever; no valvular disease.
80	36		24 0	Incompetency of aortic valves.
81	32		18 0	Old pericarditis and disease of aorta, without material valvular disease; dysentery after typhoid fever
82	40		12 0	Aortic valvular obstruction; malformation.
83	40		16 0	Recent pericarditis; aortic and mitral valves somewhat thickened; aorta dilated and diseased.
84	40		15 0	Fever, with jaundice; some thickening of mitral valves, and hypertrophy of left ventricle.
85	44		15 8	Phthisis after fever; no valvular disease.
86	45		11 8	Fever; white spots on pericardium; some thickening and opacity of aortic and mitral valves.
87	42		14 12	Chronic bronchitis; some thickening of aortic and mitral valves.
88	45		13 8	Fever; hypertrophy, with dilatation of left ventricle; no valvular disease.
89	43		13 8	Chronic bronchitis and emphysema; no valvular disease.
90	40		16 0	Pericardium universally adherent; aortic valves healthy; mitral somewhat thick.
91	42		13 6	Fever; no valvular disease.



## WEIGHT OF DISEASED HEARTS—MALES—CONTINUED.

No.	Age.	Weight of		Cause of Death, and kind of Disease.
		Body.	Heart.	
	Years.	lbs.	oz.	dr.
92	43		14	8
93	44		17	4
94	45		16	4
95	46		10	0
96	44		20	0
97	40		16	8
98	50		11	12
99	51		13	0
100	51		13	12
101	51		21	8
102	53		11	8
103	55		23	0
104	52		12	8
105	58		12	8
106	50		23	8
107	59		14	8
108	53		10	8
109	57		13	0
110	52		14	8
111	51		21	8
112	58		23	0
113	67		13	0

Recent pericarditis; chronic bronchitis; hypertrophy of right and left ventricles.  
 Old pericarditis; no valvular disease; great hypertrophy of left ventricle.  
 Chronic bronchitis; thickening of mitral and aortic valves; dilatation of aorta.  
 Phthisis; white spots on pericardium; no valvular disease; aneurism of aorta.  
 Obstructive and regurgitant disease of aortic valves; rupture of aorta; dissecting aneurism.  
 Obstruction of regurgitant disease of aortic valves.  
 Pleuropneumonia; old pericarditis; thickening of mitral valves.  
 Pericarditis; bronchitis; aneurism of coronary artery; dilatation of cavities, with atheromatous disease of aortic and mitral valves, and of aorta.  
 Fever; no valvular disease.  
 Extensive thickening and contraction of mitral, aortic, tricuspid and pulmonic valves; great hypertrophy of right ventricle; thickness, 4, 5, and 2 lines; old pericarditis; morbus renum.  
 Chronic bronchitis; white spots on pericardium and adhesions.  
 Aortic valves incompetent and some disease of aorta.  
 Chronic phthisis; no valvular disease.  
 Hemiplegia; no valvular disease.  
 Aorta much dilated and diseased; no material valvular disease.  
 Aortic valves thickened and ossified, and aorta diseased.  
 Compound dislocation of astragalus; recent pericarditis.  
 Cut throat—no valvular disease; dilatation and hypertrophy of left ventricle; aorta dilated and diseased.  
 Morbus renum; mitral thickened; left ventricle hypertrophied.  
 Mitral valvular disease, with some thickening of aortic valves and diseased aorta.  
 Much obstruction at aortic orifice and some regurgitation; mitral valve slightly thickened; aorta dilated.  
 Chronic bronchitis and emphysema; thickening of mitral valve and hypertrophy of left ventricle.

## WEIGHT OF DISEASED HEARTS—MALES—CONTINUED.

No.	Age.	Weight of		Cause of Death, and kind of Disease.
		Body.	Heart.	
	Years.	lbs.	oz. dr.	
114	60		11 8	Ulcer of stomach; pneumonia; opacity of aortic and mitral valves; aorta dilated and diseased.
115	57		16 0	Phthisis; valves healthy, but mass of bone projecting into upper part of orifice from walls of aorta.
116	65		18 4	Apoplexy; thickening of mitral and aortic valves; hypertrophy and dilatation of left ventricle; diseased aorta.
117	62		14 0	No valvular disease; hypertrophy with dilatation.
118	71		23 0	Diseased prostate; no valvular disease; hypertrophy, with dilatation of right and left ventricle; aorta dilated.
119	74		19 8	Convulsions; thickening and ossification of aortic valves.
120	78		21 0	Thickening and ossification of aortic valves; some thickening of mitral; dilatation of aorta.
121	80		14 8	Fractured arm and delirium tremens; white spots on pericardium; no material valvular disease.

## WEIGHT OF DISEASED HEARTS—FEMALES.

No.	Age.	Weight of		Cause of Death, and kind of Disease.
		Body.	Heart.	
		lbs.	oz. dr.	
122	5 mos.	11	2 4	Malformation; aperture in septum of ventricles, with contraction of tricuspid orifice.
123	14 yrs.	95	11 12	Morbus renum.
124	17		11 0	Fever; some thickening of mitral valve, with hypertrophy and dilatation of left ventricle.



## WEIGHT OF DISEASED HEARTS—FEMALES—CONTINUED.

No.	Age.	Weight of		Cause of Death, and kind of Disease.
		Body.	Heart.	
	Years.	lbs.	oz. dr.	
125	16		11 8	Lobular pneumonia; thickening and opacity of mitral valve.
126	24		15 8	Morbus renum; no material valvular disease.
127	29		11 8	Fatty degeneration of heart and kidneys.
128	21		18 0	Great contraction of mitral orifice and thickening of valve, as well as of pulmonic and tricuspid; aortic orifice small.
129	28		12 0	Morbus renum; coma; hypertrophy, with dilatation of left ventricle.
130	29		8 8	Phthisis; aneurisma aortæ.
131	34		15 0	Phthisis; pneumonia; general hypertrophy and dilatation without valvular disease.
132	34		12 8	Chronic bronchitis and emphysema; hypertrophy of right ventricle; no material valvular disease.
133	36		12 0	Fever; no valvular disease.
134	36		13 12	Morbus renum; no valvular disease.
135	30		12 8	Phthisis; no valvular disease; aorta greatly dilated.
136	40		17 0	Combined mitral, aortic, and tricuspid valvular disease; chiefly aortic regurgitation.
137	44		23 0	Great incompetency of aortic valves; orifice dilated and valves thickened and indurated.
138	50		11 8	Chronic bronchitis; no valvular disease; hypertrophy and dilatation of right ventricle.
139	53		23 0	Combined mitral and aortic valvular disease; pleurisy.
140	57		12 8	Chronic phthisis.
141	60		14 0	Dissecting aneurism of descending aorta; no valvular disease.
142	60		17 8	Dilatation of aorta; and great hypertrophy and dilatation of left ventricle, without valvular disease.
143	66		18 0	Injury of head; no valvular disease; dilatation of aorta; hypertrophy and dilatation of left ventricle.
144	66		8 12	Recent endocarditis destroying aortic valves; pneumonia; meningitis.
145	67		18 8	Contraction of aortic orifice, and induration and thickening of valves.
146	70		13 0	Apoplexy; aortic valves thick and rigid; aorta dilated and atheromatous; hypertrophy of left ventricle.

## PART I.—WEIGHT OF THE HEALTHY HEART.

TABLE I.

*Showing the weight of the healthy heart in males and females, at different periods of life, as deduced from 155 observations; males 94; females 61.*

Ages.	Males.		Females.	
	Nos. Weighed.	Mean Weight.	Nos. Weighed.	Mean Weight.
Years.		oz. dr.		oz. dr.
15 to 20	9	8 2 $\frac{6}{9}$	9	8 1 $\frac{6}{9}$
20 to 30	27	9 0 $\frac{4}{27}$	21	8 10 $\frac{9}{21}$
30 to 40	31	9 7 $\frac{5}{31}$	19	8 13 $\frac{6}{19}$
40 to 50	9	9 11 $\frac{1}{9}$	5	9 3
50 to 60	15	9 12	6	9 7 $\frac{2}{6}$
60 to 70	3	10 13 $\frac{1}{3}$	1	7 0
	94		61	

TABLE II.

*Showing the different weights of the healthy heart in males and females, between 20 and 55 years of age, deduced from 125 observations.*

Weights.	Males.		Females.	
	Nos. Weighed.	Per Centage.	Nos. Weighed.	Per Centage.
oz. oz. drs.				
5 to 6	2	5·2	3	12·2
6 to 7	2		3	
7 to 8	10		10	
8 to 9	20	39·4	12	44·8
9 to 10	18	39·4	13	42·8
10 to 11	12		8	
11 to 11 12	12	15·7		
	76		49	

Average weight of the healthy heart in 76 males from 20 to 55 years of age, . . . . . 9 8 $\frac{56}{76}$ <sup>5</sup>  
 Ditto . . . . . ditto in 49 females . . . . . 8 13 $\frac{8}{49}$

From the above table all organs weighing more than 11 oz. 12 dr. are excluded; if the cases, in which, without other disease, it weighed 12 oz. be calculated, the observations are extended to 83 males and 51 females, and the average weight of the heart in males is 9 oz. 11 $\frac{81}{83}$ <sup>5</sup> dr.; in females 8 oz. 15 dr.



TABLE III.

*Weight of the healthy heart, in persons from 20 to 55 years of age, in cases of phthisis, and all others, exclusive of bronchitis and morbus renum, specifying the average weight in acute and chronic diseases, separately.*

	Nos. Weighed.	Mean Weight.		Extremes.				Mean Age.
MALES.		oz.	dr.	oz.	dr.	oz.	dr.	Years.
Phthisis.....	27	9	3 $\frac{11}{27}$ ·5	11	0	and	6 4 $\frac{1}{2}$	34·03
All others .....	44	9	9 $\frac{39}{44}$					36
Acute cases only ...	30	9	13 $\frac{35}{30}$	11	12	„	8 8	36
Chronic cases only..	14	8	14 $\frac{10}{14}$ ·5	11	8	„	5 0	35·9
FEMALES.								
Phthisis.....	17	8	6 $\frac{1}{17}$	11	0	„	5 8	34·4
All others .....	23	9	2 $\frac{9}{23}$					31·4
Acute cases only ...	16 } 1	9	5 $\frac{3}{16}$	11	0	„	7 4	34·3
Chronic cases only..	6 }	8	9 $\frac{2}{6}$	9	8	„	8 0	30·2

The above table contains only the cases in which the weight of the heart did not exceed 11 oz. 12 dr.; if those in which it weighed 12 oz. be included, the result will stand as follows:—

Males,	Phthisis,	30	.....	9 oz.	7 $\frac{16}{30}$ ·5 dr.
„	Other,	47	.....	9 „	12 $\frac{6}{47}$ „
Females,	Phthisis,	17	.....	8 „	6 $\frac{1}{17}$ „
„	Other,	24	.....	9 „	4 $\frac{7}{24}$ „

TABLE IV.

*Weights of the heart in all cases of phthisis, bronchitis, and morbus renum; compared with the weights of the healthy heart in all other cases, hypertrophy, pericarditis, and morbus aortæ excluded.*

Weights.	Phthisis.		Bronchitis.		Morbus Renum.		All others.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
5 oz. to 6 oz.		3					2	
6 „ to 7 „	2	2				1		
7 „ to 8 „	6	3			3	2	1	5
8 „ to 9 „	2	4		2	1		17	7
9 „ to 10 „	10	1				3	8	9
10 „ to 11 „	6	4	1	1	1	1	4	2
11 „ to 12 „	4		1	1	1	2	10	
12 „ to 13 „	3	2	2	1				
13 „ to 14 „			3			1		
14 „ to 15 „		1	3		1			
15 „ to 16 „	1					1		
Mean age.....	34·1	35·3	46·4	38·4	30·1	33·4	36·5	31·4

<sup>1</sup> One case, in which the disease causing death is not stated, is excluded from this calculation.

TABLE V.

*Weight of the heart in males and females under 20 years of age.*

Age.	MALES.						Age.	FEMALES.							
	No.	Mean Weight.		Heaviest.		Lightest.		No.	Mean Weight.		Heaviest.		Lightest.		
		oz.	dr.	oz.	dr.	oz.			dr.	oz.	dr.	oz.	dr.	oz.	dr.
6 months	1	0	13 $\frac{1}{2}$				7 days	1	0	13					
10 months	1	1	10				2 $\frac{1}{2}$ months	1	1	3					
2 and 2 $\frac{1}{2}$ yrs.	2			2	12	2	10	3 months	1	1	0				
3 years	1	2	15				1 year	1	2	0					
4 and 4 $\frac{1}{2}$ yrs.	2			4	4	2	9	1 $\frac{3}{4}$ year	1	1	8				
3 years	1	3	0				3 years	1	1	10					
8 "	1	6	4				5 "	1	2	14					
10 "	1	4	4				6 "	1	2	12					
11 "	5	5	10 $\frac{4}{5}$	8	8	4	0	7 "	2			3	0	2	3
14 "	2			9	0	6	8	8 "	2			5	1	3	0
15 "	2			8	0	6	0	11 "	1	3	14				
16 "	3	6	5 $\frac{1}{3}$	7	0	5	8	13 "	1	6	2				
17 "	1	8	8					17 "	2			7	0	4	8
19 "	1	11	0					18 "	3	9	5	10	8	7	15
	24							19 "	2			8	0	7	12
									21						

Of the observations included in this table, all but 11 were cases of acute disease, and the results would not have been materially different had the cases of chronic disease been excluded from the calculation. The difference in the weights of the heart at different ages, in young persons, is chiefly due to the relative vigour of the children and the greater or less rapidity with which their growth proceeds; and in this respect the rate of growth of the heart corresponds with that of the brain and indeed of the body generally.

## INFERENCES.

1. *The average weight of the healthy heart in persons from 20 to 55 years of age, is in males 9 oz. 8 dr., and in females 8 oz. 13 dr. The mean difference between the weights of the organ in the two sexes being thus 11 drachms.*

This calculation is based only upon the observations in which the heart weighed less than 12 oz., if those in which it attained the weight of 12 oz. be added, the average becomes somewhat higher,



or 9 oz. 11 dr. in males, and 8 oz. 15 dr. in females, and the difference between the weights in the two sexes is 12 drachms.

Calculations of this description must always be to a certain extent arbitrary, for as the heart is found in some cases to be considerably above its ordinary weight, without the proportion of its walls and cavities being materially altered or the organ being otherwise diseased, it is not easy to say at what point it ceases to be healthy. The estimates of the weight of the healthy heart here given differ in some degree from those of other observers. Bouillaud<sup>1</sup> infers that the average weight of the heart is from 8 to 9 oz. (*système usuel*, or from 8 oz. 10 dr., to 9 oz. 11 dr. *avoird.*), and may amount to 10 or 11 oz. (10 oz. 12 dr., and 11 oz. 14 dr. *avoird.*), but his observations refer to only 14 cases, and include individuals of both sexes and of various ages from 16 to 38. The mean weight of 8 adult hearts given in his table is 9 oz. 2 dr. (9 oz. 15 dr. *avoird.*), the extremes being 7 oz. 6 dr. (8 oz. 5 dr. *avoird.*), and 11 oz. 3 dr. (12 oz. 4 dr. *avoird.*)

Dr. Clendinning<sup>2</sup> estimates the average weight of the male heart in persons from 20 to 60 years of age, at  $8\frac{1}{2}$  oz. *avoird.*, the female heart at  $7\frac{2}{3}$  oz. *avoird.*; and his calculations are based upon 118 observations (58 males and 60 females). Dr. Reid's<sup>3</sup> researches give the average weight of the heart in 89 males, from 25 to 55 years of age, as 11 oz. 1 dr., and in 53 females, as 9 oz.; the difference being  $2\frac{1}{2}$  ounces.

2. *The weight of the healthy heart differs in different forms of disease, being greater in persons who die after short periods of illness, and less in those who have suffered from protracted and emaciating diseases.*

This result is illustrated in table 3, from which it will be seen that the weight of the heart in adult males who sank under acute diseases, averaged 9 oz. 13 dr., while in those who had died of chronic diseases, phthisis, bronchitis, and *morbus renum* being excepted, it averaged 8 oz. 14 dr. In females the heart weighed in those who had died of acute diseases, 9 oz. 5 dr., and in those who sank from chronic diseases, 8 oz. 9 dr.

Dr. Reid found the mean weight of the heart in 9 adult males, who had died from accidents, to be 12 oz. 6 dr., while, as before stated,

<sup>1</sup> *Maladies du Cœur*, 2me Ed. 1841, t. i., p. 25.

<sup>2</sup> *Med. Chir. Trans.* vol. xxi., 1838, p. 55.

<sup>3</sup> *Lond. and Ed. Monthly Journal of Medical Science*, 1843. Also *Physiological, Pathological, and Anatomical Researches*, Edin. 1848, p. 376.



in the adult males who sank from disease it weighed on an average 11 oz. 1 dr.; but in both these calculations the weights of hearts are included which exceeded what I have regarded as the limit of health, either in cases of accident or disease.

The general inference to be deduced from these observations, would appear to be that in adult males, who have died from acute diseases or from the effects of accidents, the ordinary weight of the healthy heart is from 9 to 11 oz. avoird., and in those who have died from chronic diseases from 8 to 10 oz. In females the ordinary weight of the heart in acute cases may be regarded as from 8 to 10 oz., and in chronic diseases from 7 to 9 oz. Occasionally, however, in persons of small and delicate frame, who have died from exhausting diseases such as cancer of the stomach or chronic affections of the liver, the heart will be found to weigh only 5 or 6 oz.; and in large and powerful persons, of the male sex, who have been suddenly killed or have died after a very short illness, the organ may weigh 12 oz. or perhaps even more, without exceeding the limit of health.

3. *The heart usually increases in weight with the advance of life.*

This inference is borne out by the facts collected in table 2; for the exception formed by the single case in advanced life, in females, is unimportant. It is also confirmed by the observations of Drs. Clendinning and Reid, and by a table compiled from their data, in Dr. Sharpey's edition of Quain's Anatomy.<sup>1</sup> It is not, however, clear, to what period of life this increase extends, and whether in very advanced age there is not, as is shown to be the case with the brain, a more or less marked decline in weight.<sup>2</sup> Hospitals do not afford the means of ascertaining satisfactorily the weight of the heart in aged persons, for comparatively few old people die in them, and of these a large proportion labour under some form of cardiac disease; it is therefore very desirable that medical men having charge of public charitable institutions for the aged, should direct their attention to this point. From some observations which I have made, I have been led to suppose, that when entirely free from disease, the heart, so far from continuing to increase in weight to the term of life, undergoes a decrease in advanced age; and I have more especially

<sup>1</sup> Vol. ii. p. 1124.

<sup>2</sup> See observations by Dr. Reid and myself, in Lond. and Edin. Journal, 1843, and 1846, and by myself in the Lond. Journal of Medicine, 1851.



noticed this to be the case in females, in whom the decrease of weight of the brain in advanced life, is noticed at the earliest period and to the greatest extent. The opposite result arrived at by other observers, I cannot but suspect to have been due to organs not strictly healthy having been included in their calculations.

4. *Weight of the heart in cases of Phthisis.*

The weight of the heart in persons who have died of phthisis, is less than in those who have sunk from other diseases; but the decrease of weight after death from that disease is usually not so marked as in persons who have died from other chronic affections, unconnected with disease of the lungs.

This inference is deduced from the facts which appear in table 3, there being, however, an exception as to the relative weight of the heart in phthisis and in other chronic diseases in females; but the latter cases are too few in number to form a satisfactory basis for generalization.

The conclusion here drawn as to the relative weight of the heart in phthisis and in other diseases, differs considerably from that arrived at by Dr. Clendinning, that the weight of the heart in phthisis is greater than its weight in other diseases in which the organ is healthy. I have therefore carefully compared the two series of observations with the view of ascertaining the cause of the discrepancy. After re-calculating the data collected by Dr. Clendinning, separating from them all the weights which exceeded the limit of health, and classifying the remainder according to the acute or chronic character of the disease occasioning death, the results are as follows :

			oz.	dr.
Males.	Weight of the heart in cases of phthisis		9	9
"	"	" of acute disease only	9	1
"	"	" of chronic disease only	8	0
Females.	Weight of the heart in cases of phthisis		7	13
"	"	" of acute diseases only	8	8
"	"	" of chronic diseases only	7	8

It will thus be seen that it is only in reference to males that the observations collected by Dr. Clendinning, bear out the inference which he has drawn from them, that in phthisis the heart is heavier than in other diseases. In females, the results are similar to those deduced from the larger series of data contained in this paper, and show that the weight of the heart in phthisis is ordinarily less than in acute diseases but greater than in other chronic diseases,



unconnected with obstruction in the lungs. The correct explanation most probably is that in phthisis there is a tendency to enlargement of the heart, which, though counteracted to a greater or less extent by the emaciation, prevents the organ declining so much in weight as would have been the case were no source of obstruction present. This inference, though different both from the conclusions of MM. Louis and Bizot and Dr. Clendinning, is quite compatible with the correctness of their observations, and the different results arrived at by them and by myself are doubtless due to their having compared the condition of the heart in phthisis with its state in *all* other diseases, instead of with its weight and size in *chronic* diseases *only*. There is certainly nothing in phthisis which prevents the heart becoming considerably hypertrophied, when the tuberculous affection is combined with chronic bronchitis, valvular or aortic disease or other causes of obstruction. This is shown by two cases included in Dr. Clendinning's paper, in which the heart weighed 13 oz. 4 dr. and 13 oz. 8 dr. in males; and by others in my own in which it weighed 15 oz. 8 dr. in a male, and 15 oz. in a female.

5. *Weight of the heart in cases of Chronic Bronchitis.*

The facts collected in table 4 show, that in chronic bronchitis the heart ordinarily acquires a considerable increase of weight. In two cases only of persons who had died of this disease did the organ possess its average weight in chronic diseases; while in 9, 8 males and 1 female, it exceeded the weight regarded as the extreme limit of health; and, in three of them, all of whom were males, it weighed from 15 to 16 oz. Though the number of cases contained in the table is so few, yet the results are too marked to be regarded as accidental.

6. *Weight of the heart in cases of renal disease.*

The condition of the heart in cases of disease of the kidneys is also shown in table 4; and from this it will be seen that in 7 cases, or 4 males and 3 females, the weight of the organ was below the average in other chronic diseases; while in 11, 3 males and 8 females, it exceeded the average, attaining in one male the weight of 14 oz. 8 dr., and in 2 females of 13 oz. 12 dr., and 15 oz. 8 dr. The facts, therefore, confirm, to a certain extent, the observations of Dr. Bright,<sup>1</sup> that the disease of the kidneys, unconnected with valvular disease or disease of the aorta, has a tendency to produce enlargement of the heart.

<sup>1</sup> Guy's Hospital Reports, vol. i., 1836, p. 380.



## PART II.—WEIGHT OF DISEASED HEARTS.

TABLE VI.

*Weight of the heart in cases in which it exceeded the limit of health, but in which there was no obvious source of obstruction; and in cases of old adhesions of pericardium, and disease of the aorta (including atheromatous deposit, dilatation, and aneurism), unconnected with valvular defect.*

Weights.	Hypertrophy without Obstruction.		Adhesions of the Pericardium.		Aortic Disease.			
	Males.	Age.	Males.	Age.	Males.	Age.	Females.	Age.
8 oz. 8 dr.							1	29*
10 " 0 "					1	46*		
11 " to 12 oz.			1	50	2	38* and 60		
		Mean.						
12 " to 13 "	5	37·2			2	57 and 65	1	30
13 " to 14 "	5	50					1	60
14 " to 15 "	4	46·7			1	29		
15 " to 16 "	1	34	1	40	1	45		
16 " to 20 "	2	45 and 34	2	44 and 32	4	38 to 78 Mean 56·4	2	60 and 66
20 " to 24 "					5	30* to 71 Mean 52·2.		
40 " to 12 dr.	1	65						

In 11 out of the 18 cases of hypertrophy included in the table it is stated in the reports that there was no valvular disease; and in the others any slight thickening, opacity, or atheroma which existed was inadequate to explain the increase of weight. In all the cases, also, there was an absence of material chronic disease of the lungs and aorta.

In two females the hearts weighed 11 oz. and 12 oz. in persons of 17 and 36 years of age: in the former, though there was slight thickening of the mitral valves, it was inadequate to explain the unusual weight of the heart for a person of the age, and in the second there was no valvular disease.

From the table all the cases in which there was recent pericarditis are excluded; one instance, in which the pericardium was universally adherent by old attachments, and there was chronic bronchitis,

is also omitted. In the case of the male, 32 years of age, in whom the heart weighed 18 oz., there was not only adhesion but extensive ossification of the pericardium. The cases marked with an asterisk were aneurisms. In two of these in which the heart weighed 8 oz. 8 dr. and 24 oz., the patients were phthisical, and this was also the case in the female in whom the heart weighed 12 oz. 8 dr., and the aorta was dilated.

TABLE VII.

*Weight of the heart in cases of aortic valvular disease, whether obstructive, regurgitant or both.*

Weights.	Males.			Females.		
	Obstruct.	Obst. and Regurgit.	Ages.	Obstruct.	Obst. and Regurgit.	Ages.
8 oz. and 12 dr.			Years.			Years.
10 " and 12 "					1	66
11 " to 12 oz.	1	1	40 and 57	1		75
12 " to 13 "				1		70
14 " to 15 "	2	2	44·7			
15 " to 16 "	3	3	45·5		1	46
16 " to 20 "	1	3	47·7	1		67
20 " to 25 "	1	8	44·5		1	44
28 "		1	18			
34 "		1	55			

In several of these cases there was also dilatation or atheromatous disease of the aorta, and generally some thickening of the mitral valve.

TABLE VIII.

*Weight of the heart in cases of mitral valvular disease.*

Weights.	Males.	Age.	Females.	Age.
8 oz. and 8 dr.		Years.		Years.
10 " and 8 "			1	27
11 "			1	23
12 " and 12 oz. 8 dr.			1	17
14 " and 14 " 8 "	2	29 and 52	2	62 and 40
15 " and 12 dr.			1	39
17 " and 8 "	1	36		
18 "			1	21

Of the cases included in this table the male in whom the heart weighed 14 oz., and the two females in whom it weighed 8 oz. 8 dr.



and 11 oz. died respectively of attacks of cholera, peritonitis and fever.

In one case not entered in the table, there was free regurgitation through the left auriculo-ventricular aperture from dilatation without disease of the valves, and the organ weighed 10 oz. 8 dr. ; the subject being a girl 8 years of age. In several cases the tricuspid valves were also slightly thickened.

TABLE IX.

*Weight of the heart in cases of combined aortic and mitral valvular disease.*

Weights.		Males.	Age.	Females.	Age.
oz.	dr.				
7	8			1	11
12	0			1	12
13	8			1	18
14	8	1	24		
17	0			1	40
18	4	1	65		
21	8	1	51		
22	0			2	39 and 63
23	0			1	53

In the three cases in which the organ attained the greatest weight, the predominant valvular disease was mitral. In that in which the heart weighed 21 oz. 8 dr., the pericardium was also universally adherent, and there was considerable thickening of the tricuspid valves and disease of the aorta ; and in some of the other cases the tricuspid valves were also slightly thickened.

#### INFERENCES.

1. *The weight of the heart may very greatly exceed the limit of health without the existence of any material valvular, aortic or pulmonic disease, adhesions of the pericardium or obvious source of obstruction in the larger vessels.*

Thus it will be seen in Table VI. that in 18 males, the weight of the heart exceeded 12 oz., and in 5 cases it amounted to 15 oz., 16 oz., 17 oz. 8 dr., 20 oz. and 40 oz. 12 dr., the last being the heaviest heart weighed. In all these cases there existed no source of obstruction either in the heart itself or in the aorta or lungs



which appeared sufficient to explain the great increase of weight, and in 11 of them it is expressly stated in the reports that there was no valvular disease. In the case in which the heart weighed 40 oz. and 12 dr., though there was slight atheromatous change in the aortic and mitral valves and in the coats of the aorta, the lungs were healthy and nothing sufficient to explain the hypertrophy was detected.

The process by which the heart attains this great increase of weight in cases where there is no marked obstruction to the circulation, is most probably a slow one; but the data given show that there is no relation between the age of the individual and the amount of hypertrophy. The heart is found to weigh very considerably above the average in comparatively young persons, and the more extreme degrees of hypertrophy are not more common in advanced age than in persons at earlier periods of life.

In females only two cases which could be regarded as instances of simple hypertrophy are included in the tables, and in neither of these did the organ exceed 12 oz. in weight;—facts which show the infrequency of this form of disease in females, and the very slight increase of weight which the female heart attains when there is no serious source of obstruction.

2. *Weight of the heart in cases in which the Pericardium is adherent.*

The tables contain only four cases in which there were old adhesions of the pericardium, without valvular, aortic or pulmonic disease or recent pericarditis;—and this number is too small to warrant any decided inferences. It will, however, be seen that in one instance the weight of the heart did not exceed the limit of health, being only 11 oz. 12 dr.; while, in the other three cases, it was very considerably greater, or 16 oz., 17 oz. 4 dr., and 18 oz. These facts do not confirm the opinion that adhesions of the pericardium, so far from leading to enlargement of the heart, rather tend to produce atrophy; but I have examined other hearts in which the pericardium was entirely adherent by old cellular attachments, without the organ being larger than natural. The person in whom the heart weighed 18 oz. was a male, 32 years of age, and, in this instance, not only was the pericardium much thickened and adherent but there was also a considerable formation of bone.

3. *The heart most generally acquires very great increase of weight in cases of disease of the aorta, whether consisting in atheromatous deposit, ossification of the coats, dilatation, or sacculated aneurism; but in none of the cases of this description did the heart attain so great a weight*



*as in one of those in which there existed no obvious source of obstruction to explain the enlargement.*

The last column in Table VI. shows that in one female the weight of the heart did not attain the average, being only 8 oz. 8 dr. In one male also it only slightly exceeded the average, being 10 oz. ; and in two other males it did not exceed the limit of health, weighing in each 11 oz. 8 dr. In the remaining cases (seventeen in number—thirteen males and four females), it very considerably passed that point, weighing from 12 oz. to 24 oz. in males, and from 12 oz. 8 dr. to 18 oz. in females ; the greatest weights being, in males, 16 oz. 4 dr., 18 oz. 4 dr., 19 oz., 21 oz., 23 oz., 23 oz. 8 dr., and 24 oz. ; and in females, 17 oz. 8 dr., and 18 oz. It must, however, be observed, that in the male in which the heart weighed only 10 oz., in a second in which it weighed 24 oz., and in the female in whom it weighed 8 oz. 8 dr., in addition to the aneurisms, the lungs were tuberculous ; and in the female in whom the heart weighed 12 oz. 8 dr., the aorta was dilated and the lungs tuberculous ; so that, in these instances, the hypertrophy of the heart resulting from the aortic obstruction, may have been to some extent counteracted by the emaciation from phthisis.

As in the cases of hypertrophy only, so also in this form of disease there is no just relation between the ages of the individuals and the increase in the weight of the heart.

4. *The heart usually becomes very greatly enlarged in cases of aortic valvular disease, whether obstructive or regurgitant, or both ; and the increase of weight is apparently greater in these cases than in those of disease of the aorta. In no instance, however, did the organ acquire from this cause so great a weight as in one of the cases of hypertrophy unconnected with obvious obstruction.*

These inferences are deduced from Table VII., from which it appears that in males the weight of the heart exceeded the average in all the cases ; but, in two instances, in one of which there was obstruction only, in the other regurgitation, it did not pass the extreme limit of health, weighing only 11 oz. 8 dr., and 12 oz. In seven other cases of obstruction its weight ranged from 14 to 21 oz., the greatest weights being 16 oz., 16 oz., 19 oz., and 21 oz. ; and in eighteen cases of regurgitation, from 14 oz. to 34 oz. ; the greatest weights being 20 oz., 21 oz., 22 oz. 4 dr., in three cases 23 oz., 23 oz. 8 dr., in two cases 24 oz., 28 oz., and 34 oz.

In females the increase of weight in cases of aortic valvular disease



also obtains, though to a less degree. If a case in which one of the segments was destroyed by acute endocarditis and death rapidly ensued, and the organ weighed only 8 oz. 12 dr., be excluded, the lightest heart in the table weighed 10 oz. 12 dr., or within the limit of health. In this instance, there was most extensive thickening and ossification of the valves, probably originating in malformation, and causing extreme obstruction: and as the subject of the case was 75 years of age, the progress of the disease must have been very slow. In two other cases of obstructive disease the heart weighed 13 oz. and 18 oz. 8 dr.; and in two cases of regurgitation 16 oz. and 23 oz.

It will thus be seen that, though the weight of the heart in cases of aortic valvular disease was greater than in the cases of disease of the aorta, the heaviest heart in the former weighed nearly 7 oz. less than in the remarkable case of hypertrophy without valvular or aortic disease before mentioned.

The table also shows that the weight of the heart in cases of aortic valvular disease is by no means proportionate to the age of the subjects; the organ having attained a weight of 28 oz. in a boy of 18, and 23 oz. in a female of 44.

It is not possible to ascertain the respective effects of obstructive and regurgitant disease in increasing the weight of the heart, for the two generally coexist, and the latter is very frequently only the final stage of the former; the influence which is due to each cause cannot therefore generally be assigned. In the case, however, in which the heart weighed  $17\frac{3}{4}$  oz. in a male 33 years of age, the disease was the result of rupture of the angle of attachment of two of the valves from violent muscular exertion, 27 months before death, and though there must have been some obstruction to the flow of blood from the ventricle into the aorta, the great increase of weight must have been chiefly due to the incompetency of the valves. A still more remarkable instance of enlargement from regurgitation, is afforded by a case of rupture of the valves related by Dr. Quain, in which the heart acquired the weight of  $22\frac{1}{2}$  oz. in a period of two years which elapsed between the occurrence of the accident and the death of the individual. In both these cases the heart was most probably healthy till the accidents occurred.

In all cases of regurgitant disease on whatever cause dependent, the increase of weight probably takes place rapidly; thus, in the boy of 18, in whom the organ weighed 28 oz., the duration of illness had



only been two years and ten months. On the contrary, in cases of obstructive disease, the enlargement of the heart is probably a slower process. A striking example of the length of time during which obstruction may exist without the heart acquiring great increase of weight, is afforded by the case of the elderly female, before referred to, in whom the organ weighed 10 oz. 12 dr. ; but in this instance, it seems probable that a decrease of weight may have occurred with the advance of life. The case, however, with many others which might be quoted, shows the absence of any just relation between the degree of obstruction and the amount of hypertrophy.

5. *In cases of mitral valvular disease the heart ordinarily exceeds the limit of health, but does not attain so great an increase of weight as in aortic or aortic valvular disease.*

Of the cases included in Table VIII., three, that of the male in whom the heart weighed 14 oz., and two females, in whom it weighed 8 oz. 8 dr., and 11 oz., death did not result from the direct effect of the disease but from other causes. If, therefore, these cases be excepted, it will be seen that in one female the heart weighed only 10 oz. 10 dr., or within the limit of health; while in the six other cases it greatly exceeded that point, weighing, in males, from 14 oz. 8 dr. to 17 oz. 8 dr., and in females from 12 oz. to 18 oz. These weights are, however, much less than those in the cases of aortic and aortic valvular disease, and still less than that of the heart in which the hypertrophy was not dependent on obvious obstruction. It will also be observed that in these cases there is not the great difference in weight between the male and female heart which is observed in other forms of disease, but the cases are so few that the inferences cannot be fully depended upon.

The weight of the heart in cases of mitral valvular disease bears no certain proportion to the age of the individual, as is shown by the subject of the case in which the heart weighed 18 oz. being a female only 21 years of age.

6. *In disease of the mitral and aortic valves combined, the weight of the heart is generally intermediate between that in cases of aortic and mitral disease alone; the organ being lighter than in aortic valvular disease, and heavier than in mitral valvular disease.*

It will be seen from Table IX., that if the case in which the heart weighed 7 oz. 8 dr., in a girl 11 years of age, be omitted, in all the observations, including two females of 12 and 18 years of age, the weights of the heart exceeded the extreme limit of health ;



and that in three males it weighed from 14 oz. 8 dr. to 21 oz. 8 dr., and in three females from 17 oz. to 23 oz.

7. The tables contain only one observation of the weight of the heart in extensive *disease of the mitral and tricuspid valves*. In this instance the disease was probably congenital. The organ weighed 9 oz., and the subject was a female 37 years of age, but she was peculiarly ill-formed and stunted, and did not appear more than 16 or 18 years old.

8. In the tables the weights of four hearts are given in which there were *congenital malformations*. Of these cases that which presented the least important deviation from the natural structure, was one in which the foramen ovale was unclosed, in a girl  $8\frac{1}{2}$  years of age, and the heart weighed 6 oz. 8 dr. A second case was that of a girl aged 5 years, who died of hæmorrhage from the throat or stomach, during an attack of scarlet fever, and the only malformation was the existence of a septum dividing the infundibular portion of the right ventricle from the sinus, and the heart weighed 3 oz. 12 dr. In a third case, that of a boy 15 years of age, in addition to a similar source of obstruction in the right ventricle, the pulmonary artery was small and its valves malformed, and there was an aperture in the septum ventriculorum, by which the aorta freely communicated with the right, as well as with the left ventricle; in this instance the heart weighed 10 oz. In three other cases (two of which are not included in the tables), the pulmonary orifice was the seat of obstruction. In one of these, a young man, 20 years of age, it was very greatly contracted from the adhesion and thickening of the valves, and the foramen ovale was largely open, and the heart weighed 12 oz. In another, a female, 19 years of age, the pulmonary orifice was greatly contracted from malformation of the valves; the tricuspid valves were also diseased; the aorta arose from both ventricles, and the ductus arteriosus was still pervious; and the heart weighed  $17\frac{1}{2}$  oz. The subject of the third case was an infant nearly 12 months old, in which the pulmonary artery was entirely obliterated, the aorta arose from both ventricles, and the blood was transmitted to the lungs through the ductus arteriosus. The heart in this case weighed 3 oz. 8 dr. The last instance of malformation is one in which, in a female infant aged 5 months, there were two small apertures in the septum ventriculorum, with thickening of the tricuspid valves, causing contraction of the orifice, and the heart weighed 2 oz. 4 dr. A comparison of the weights of the heart



in these cases with that of the healthy organ in infancy and early life, as given in Table V., will show how greatly it exceeded the ordinary weight in healthy children at similar ages; indeed, in the female 19 years of age, it very considerably exceeded the extreme limit of health in adults.

#### GENERAL REMARKS ON THE WEIGHT OF THE DISEASED HEART.

The weights of the diseased heart in the above tables are, so far as I am aware, the most extensive series yet published; indeed with the exception of M. Bouillaud, I do not know any writer who has specially collected the weights of diseased organs. M. Bouillaud's observations are, however, very few in number, amounting to only 11 cases in which the heart was hypertrophied, and 7 which he regarded as cases of atrophy. Of the latter, in five males the weights ranged from 5 oz. 6 dr. in a person 18 years of age, to 7 oz. in one of 20, and the causes of death were marasmus, typhoid, and the effects of having taken nitric acid. The two females were aged 45 and 30, and died respectively of scirrhus of the pylorus, and of disease of the liver, and the hearts weighed 4 oz. 5 dr., and 5 oz. 13 dr. Of the observations in the paper, the lightest male heart weighed 5 oz. in a person 53 years of age, who died of cirrhosis hepatis, combined with disease of the kidneys. In a second case the heart weighed 6 oz. in a person 39 years of age, who died of cancer of the pylorus, and in a third, the heart had the same weight in a man 29 years old, the cause of whose death is not recorded. The lightest female heart weighed 5 oz. 8 dr. in two persons 25 and 35 years of age, and 5 oz. 12 dr. in a third, 21 years old, and all these died of phthisis.

The weights of the heart in the cases of hypertrophy collected by M. Bouillaud, are as follows:—

##### *Hypertrophy apparently without Valvular disease.*

1. Male,	60 years of age	.	.	12 oz. 15 dr. avoirdupois.
2. „	50 „	.	.	13 „ 11 „ „
3. Female,	75 „	.	.	14 „ 10 „ „
4. Male,	67 „	.	.	18 „ 3 „ „
5. „	69 „	.	.	17 „ 10 „ „

##### *Aortic Valvular obstruction and probably Regurgitation.*

6. Female,	54 years of age,	.	.	24 oz 4 dr. avoirdupois.
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*Mitral Valvular Regurgitation.*

7. Male, 47 years of age . . . 22 oz. 3 dr. avoirdupois.

*Mitral Valvular obstruction and Regurgitation.*

8. Female, 56 years of age . . . 12 oz. 15 dr. avoirdupois.  
 9. Male, 53 „ . . . 16 „ 3 „ „

*Combined Mitral and Aortic Valvular disease,*

10. Female, 17 to 18 years . . . 11 oz. 14 dr. avoirdupois.  
 11. Male, 40 years of age . . . 18 „ 10 „ „

In the tables in the paper the weight of only one heart is given in which there was regurgitation through the left auriculo-ventricular aperture, without disease of the valves, and in this case the patient was a girl only 8 years of age ;—so that no comparison can be instituted between the weight of the heart in M. Bouillaud's 7th observation and my own ; but, with this exception, it will be seen that the weights of the heart, in the different forms of disease in the comparatively small number of observations published by M. Bouillaud, correspond with those deduced from my own much more numerous data ; though in none of his observations did the heart attain so great a weight as in several of my own.<sup>1</sup>

In Dr. Clendinning's tables the lightest male heart weighed 6 oz., in three cases, in persons who died of ascites, mania, and phthisis, at the ages of 24, 41, and 43 ; and the lightest female hearts weighed 4 oz. 8 dr., 5 oz., 5 oz. 8 dr., and 5 oz. 4 dr., in persons aged respectively 32, 31, 20, and 26, who died of epilepsy with ulceration of the intestines, chronic bronchitis, typhus, and phthisis.

The heaviest hearts in males weighed 24 oz., 24 oz. 8dr., 26 oz.<sup>2</sup> and 40 oz. 8 dr., in persons 48, 34, 33, and 33 years of age ; but, except in reference to the last case, in which there was aneurism of the aorta near the heart, the nature of the disease causing death is not reported. It is curious that the heart in the last case should be precisely the same weight as the heaviest which I have weighed.

<sup>1</sup> In M. Bouillaud's treatise the weights are given in grammes, and also in the pound, ounce, and gros. The pound being the poid de marc of 7560·6 grains troy, and the ounce and gros respectively the medicinal weight of 472·5 and 59·1 grains. The weights given above, are avoirdupois, calculated from the gramme, as equal to 15·434 troy grains.

<sup>2</sup> This case is evidently twice inserted in the tables.



In females the greatest weights given by Dr. Clendinning are  $15\frac{1}{2}$  oz. and  $17\frac{1}{2}$  oz. in persons 23 and 50 years of age; but though the foramen ovale is stated to have been open in the former case, the precise kind of disease is not mentioned in either.

M. Bouillaud<sup>1</sup> concludes his observations with the remark that, in cases of hypertrophy, the weight of the heart may amount to nearly three times that of the organ of usual dimensions, and five times that of the most atrophied heart. It will, however, be seen, from the data here published, that this estimate is too low. As in males the average weight of the heart is 9 oz. 8 dr. (or, if the cases in which the weight of the organ was 12 oz. be included, 9 oz. 11 dr.), and the extreme weights of the organs examined were 5 oz. and 40 oz. 12 dr., the weight in the most hypertrophied heart was upwards of four times that of the average organ, and eight times that of the lightest heart weighed. In females, the range of weight in the heart, though sufficiently remarkable, is less than in males. The mean weight of the heart in females is 8 oz. 13 dr. (or 8 oz. 15 dr.), and the extreme weights are 5 oz. 8 dr. and 23 oz., so that the most hypertrophied heart was nearly three times the weight of the average organ, and four times that of the lightest heart. The greatest weight recorded was in a case of hypertrophy without material valvular disease; and the lightest hearts were found in cases of cancer of the pylorus and disease of the liver—an observation which accords with the results of M. Louis<sup>2</sup> as to the small size of the heart in cases of this description.

M. Bouillaud, in referring to the statement of Lobstein, that a heart examined by him weighed 2 lbs. (or 34 oz. avoird.), suggests that the organ had most probably been weighed before being deprived of its coagulum and blood; but this weight is so far from being extreme, that there is no reason to doubt the correctness of M. Lobstein's report. Dr. Hope<sup>3</sup> mentions having examined, at St. George's Hospital, a heart which weighed  $2\frac{1}{4}$  lbs., which, if, as is probable, the weight employed was avoirdupois, equals the heaviest organs weighed by Dr. Clendinning and myself.

<sup>1</sup> *Traité Clinique des Maladies du Cœur*, 2<sup>me</sup> Ed. 1841, Tome i. p. 68.

<sup>2</sup> *Sydenham Society's Translation*, p. 52.

<sup>3</sup> *Diseases of the Heart*, 3d Ed., 1839, p. 238.



TABLE X.—Showing the dimensions of the healthy heart in *males*, specifying in separate columns, the cases of phthisis, bronchitis, and of other diseases unconnected with pulmonary disease, together with the dimensions of the heart in persons dying of chronic diseases *only*, unconnected with disease in the lungs. The table includes the mean of all the observations, together with the dimensions of the lightest and heaviest hearts examined.

	Phthisis.			Bronchitis.			Other.			Chronic cases only.		
	Mean	Lightest	Heaviest	Mean	Lightest	Heaviest	Mean	Lightest	Heaviest	Mean	Lightest	Heaviest
	lines	lines	lines	lines	lines	lines	lines	lines	lines	lines	lines	lines
Circumference of the heart.....	94.5	92	97	118.6	116	130	103.1	98	87	104.4	98	120
Girth of right ventricle .....	49.5	50	49	67.3	66	76	55.6	54	48	57.2	54	60
" left ventricle .....	45	42	48	51.3	50	54	47.5	44	39	47.2	44	60
Length of the cavity of right ventricle ...	43.3	36	48	50	51	51	42.5	42	51	40	42	34
" left ventricle .....	37.3	36	39	40.6	45	36	37	36	40	34.4	36	32
Thickness of walls of right ventricle base	2	2	2	2.5	2	3	1.81	2	2	1.8	2	2
" midpoint .....	2	2	2	3	2.5	4.5	1.93	2.25	2	1.95	2.25	2
" apex .....	1.58	1.25	1.5	1.3	1.5	1.5	1.37	2	1	1.5	2	1.5
" of left ventricle, base	5.3	6	4	5.5	5	6	5.1	5	6	4.7	5	5
" midpoint .....	6.3	5	7	5.8	5.5	6	5.95	6	8	5.8	6	6
" apex .....	2.3	2.5	2	2.5	2	2.5	2.5	3	2	2.8	3	3
" of septum .....	5.8	5	6	5.08	5	4	5.77	6	6	5.6	6	5
Circumf. of right auriculo-ventric. aper.	49.3	51	43	58.6	62	60	54.4	57	57	57.7	57	60
" of pulmonary .....	38.6	39	29	46	45	45	40	39	42	40.8	39	42
" of left auriculo-ventricular.....	45.3	48	37	54	54	54	44.3	42	45	47.2	42	48
" of aortic.....	34.6	36	26	39	39	36	35.5	33	39	36.4	33	39

The observations in cases of phthisis are three; the ages 20, 31, and 37, and the weights of the heart, 6 oz. 4½ dr., 9 oz. 4 dr. and 11 oz. The number of cases of bronchitis, etc., is also three, the ages 38, 40, 72, and the weights of the heart 11 oz., 12 oz., 8 dr., and 14 oz. The number of other cases is twelve, the ages ranging from 23 to 66, and the mean age 32.8; the weights of the heart range from 6 oz., 9½ dr. to 12 oz., and the mean weight is 9 oz. 4.7 dr. The number of cases of chronic diseases only are five, the ages 23 to 35, the weights of the heart from 6 oz. 9½ dr. to 9 oz. 1.5 dr.



TABLE XI.—Dimensions of the healthy heart in *females*, specifying separately the dimensions in cases of phthisis, bronchitis, and of all other diseases, unconnected with pulmonary disease.

	Phthisis.			Bronchitis.			Other.		
	Mean.	Lightest.	Heaviest.	Mean.	Lightest.	Heaviest.	Mean.	Lightest.	Heaviest.
	lines	lines	lines	lines	lines	lines	lines	lines	lines
Circumference of the heart .....	102.6	90	108	93	94	92	107.8	108	120
Girth of the right ventricle .....	56	48	60	53	54	52	59	60	72
" left ventricle .....	46.6	42	48	40	40	40	48.8	48	48
Length of the cavity of the right ventricle .....	45.3	42	48	42.6	44	42	43.7	42	48
" left ventricle .....	36.6	27	42	34.6	32	36	37.5	36	39
Thickness of walls of right ventricle, base .....	1.6	1.5	1.5	3	4	2	1.81	1	2
" midpoint .....	2.3	1.5	3	2.87	4	2	1.87	1.5	1.5
" apex .....	1.3	1.5	1.5	1.87	2	1	1.18	.5	1
" of left ventricle, base .....	4.8	6	3.5	5.2	4	4	4.9	4	5
" midpoint .....	5.6	7	5	6	4	7	5.8	5	6
" apex .....	3.16	2	2	2.25	2	2	2.7	2.5	2.5
" of septum .....	3.5						4.7	4	6
Circumf. of right auriculo-ventric. aper. ....	54	51	60	47.5	51	40	52.1	54	51
" of pulmonic .....	42	42	45	37.7	39	34	39	39	42
" of left auriculo-ventricular .....	45	48	48	44.2	45	42	45.5	45	45
" of aortic .....	34	33	36	34.5	39	39	34	33	36

The cases of phthisis in the table are three in number, the ages 20, 24, and 66; the weights of the heart 7 oz., 9 oz. 5 dr., and 10 oz. 11 dr.

The cases of bronchitis are four, the ages 25 to 60, mean 47, and the weights of the heart 9 oz. to 11 oz., mean 10 oz. 2.7 dr.

The other cases, unconnected with pulmonary disease, are eight in number; the ages 20 to 64, the mean age 35.3, and the weights of the heart 7 oz. to 9 oz. 10 dr., the mean weight 8 oz. 4 dr.

The cases of chronic disease only have not been separated in this table, as they are only two in number.



## PART III.--DIMENSIONS OF THE HEALTHY HEART.

## INFERENCES.

1. *Average size of the heart and capacity of its orifices.*

In males, the average circumference of the healthy heart, in persons of adult age, dying of diseases unconnected with any pulmonary affection, measured externally, was 103.1 lines, and the extreme circumference in different cases was from 87 to 120 lines.

The girth of the right ventricle averaged 55.6 lines, that of the left ventricle 47.5 lines; but these dimensions varied greatly in different cases, the girth of the right ventricle having a range of from 48 to 60 lines, that of the left ventricle of from 39 to 60 lines.

The mean length of the cavity of the right ventricle was 42.5 lines, that of the left ventricle 37 lines. These measurements also varied—the length of the right ventricle ranging from 34 to 51 lines, that of the left ventricle from 32 to 44 lines.

The parietes of the right ventricle had an average thickness at about the middle of its anterior wall of 1.93 lines; and decreased slightly in width towards the pulmonic orifice, and about half a line towards the apex, having thus a thickness of 1.81 lines in the former situation, and of 1.37 at the apex.

The walls of the left ventricle had a medium width at about the mid-point of 5.95 lines, at the base of 5.1 lines, and at the apex of 2.5 lines. The thickness of the parietes of the ventricles exceeded or fell short of these dimensions, without passing the limit of health, in the right ventricle by half a line, and in the left by about a line and a half. The thickness of the right ventricle ranged from 1.5 to 2.5 lines; that of the left ventricle from 5 to 8 lines.

The septum of the ventricles had an average thickness at the middle of 5.77 lines, and its width ranged from 3.75 to 7 lines, generally corresponding in thickness with the parietes of the left ventricle.

The right auriculo-ventricular aperture had a mean circumference of 54.4 lines; the pulmonic orifice of 40 lines; the left auriculo-ventricular aperture of 44.3 lines, and the aortic orifice of 35.5 lines; but the dimensions of the orifices also varied greatly in different cases, the right auriculo-ventricular aperture having a range of from 45 to 60 lines, the pulmonic of from 34 to 45; the left auriculo-



ventricular aperture of from 38 to 51, and the aortic orifice of from 28 to 48.

In females the dimensions of the heart are ordinarily less than in males, but the difference is rather apparent in the diminished thickness of the walls of the ventricles and in the circumference of the orifices, than in the capacity of the cavities.

In adult females the circumference of the heart in persons dying of various affections, unconnected with disease of the lungs, had a mean of 107·8 lines, and in different cases it attained extremes of 86 to 120 lines.

The girth of the right ventricle averaged 59 lines, and varied from 49 to 72 lines in different cases. The girth of the left ventricle averaged 48·8 lines, and ranged from 38 to 69 lines.

The medium length of the cavity of the right ventricle was 43·7 lines, and it ranged from 34 to 48 lines. The left ventricle had a mean length of 37·5 lines, and extremes of 32 and 44 lines.

The thickness of the walls of the right ventricle was near the base 1·81 lines, at the midpoint 1·87 lines, and near the apex 1·18 lines; and the greatest thickness varied in different cases from 1·5 to 2·5 lines. The parietes of the left ventricle had a medium width near the base of 4·9 lines, at the midpoint of 5·8 lines, and at the apex of 2·7 lines, the greatest width ranging in different cases from 5 to 8 lines.

The septum averaged 4·7 lines in thickness, and its width in various cases was from 4 to 6 lines.

The right auriculo-ventricular aperture had an average circumference of 52·1 lines, the pulmonic orifice of 39 lines, the left auriculo-ventricular aperture of 45·5 lines, and the aortic orifice of 34 lines; and the variations in the capacity of the different orifices, were, in the right auriculo-ventricular aperture from 42 to 57 lines, in the pulmonic from 33 to 42, in the left auriculo-ventricular from 37 to 54, and in the aortic orifice from 29 to 36. It will thus be seen that while in the two sexes the dimensions of the whole heart, and the size of the cavities, did not differ materially, in females the walls were somewhat thinner, and the orifices less capacious than in males. The comparison is not, however, a just one; for, while a larger proportion of the males the dimensions of whose hearts are given, died of chronic diseases,—the females, with two exceptions, all died after short periods of illness. Had the respective proportions of cases of acute and chronic disease in the two sexes been similar, the dimensions of the heart would most probably have shown a greater difference. It



would, however, appear that in the female heart the cavities are somewhat larger, relative to the thickness of the walls, than in males.

2. *Relation of right and left sides of heart and orifices in males and females.*

From these observations it thus appears that the girth of the right ventricle, measured externally, exceeded that of the left, in males by 1-6th, and in females by 1-5th. The length of the cavity of the right ventricle exceeded that of the left ventricle, in males by about 1-7th, and in females by about 1-6th. In both sexes the thickness of the walls of the right ventricle is about 1-3d that of the parietes of the left ventricle. The thickness of the septum is intermediate between that of the external walls of the right and left ventricles.

In males the pulmonic aperture was about 1-8th more in circumference than the aortic; the left auriculo-ventricular orifice about 1-4th more than the aortic; and the right auriculo-ventricular opening one-half larger. In females, the difference between the circumference of the aortic and of the other orifices, is somewhat greater.

3. *Form of the heart.*

In the two sexes, the length of the heart measured from the base to the apex was greater than its breadth measured across the broadest part. These dimensions were taken in comparatively few cases: in these the mean length of the organ was 49 lines, and the mean breadth 43 lines.

4. *Thickness of walls of auricle; size of coronary arteries, &c.*

The walls of the right auricle measured at the middle of the sinus had a medium thickness of half a line to one line, but from the arrangement of the *musculi pectinati*, it is not easy to estimate their width. The walls of the left auricle had an average thickness of 1 to  $1\frac{1}{2}$  lines.

The right coronary artery in the cases in which it was measured had a circumference of from 5 to 8 lines; ordinarily this artery gives off the anterior branch immediately after its origin, but not unfrequently that vessel arises separately from the right sinus of Valsalva. The left coronary artery is generally larger than the right. In one case I have seen the two coronary arteries arise by a common trunk, and in another both arteries arose from the same sinus. The orifice of the coronary vein has generally a circumference of about 10 lines.

The fossa of the foramen ovale has a mean size of 8.6 lines in its longest, and 6.8 lines in its shortest diameter, but the dimensions



vary considerably. The fold on the left side ordinarily overlaps the isthmus by 2 or 3 lines, and, when a valvular opening remains, it is usually 2 to 3 lines wide.

5. *Size of heart in bronchitis, &c.*

The heart is ordinarily greater in persons who have died of bronchitis and other pulmonary diseases, phthisis excepted, than in persons who have died of affections in which there was no obstruction in the lungs. The enlargement generally consists in hypertrophy and dilatation of both the right and left ventricles;—the cavity of the right ventricle being enlarged and its walls increased in thickness; while the left ventricle, though increased in size, retains the usual thickness of its walls.

The circumference of the heart in cases of bronchitis in males, averaged 118·6 lines, and ranged from 110 to 130 lines.

The girth of the right ventricle averaged 67·3 lines, and ranged from 60 to 76 lines; that of the left ventricle averaged 51·3 lines, and ranged from 50 to 54 lines.

The mean length of the cavity of the right ventricle was 50 lines, and it ranged from 48 to 51 lines; that of the left ventricle had a medium of 40·6 lines, and extremes of 36 and 45.

The walls of the right ventricle were on the average 3 lines in width, and ranged from 2 to 4·5 lines, and in one case not included in the tables, of chronic bronchitis,—with curvation of the spine,—in a young man 17 years old, the parietes of the ventricle were fully 5 lines thick. The walls of the left ventricle had an average thickness of 5·8 lines, and ranged from 5·5 to 6 lines at the broadest part. The septum had a medium thickness of 5·08 lines, and a range of from 4 to 6 lines.

The right auriculo-ventricular aperture had a medium circumference of 58·6 lines, and extremes of 54 to 62 lines. The pulmonic orifice a medium of 46 lines, and extremes of 45 and 48. The left auriculo-ventricular aperture, in the three cases measured, was 54 lines, and the aortic had a medium of 39 lines, and extremes of 36 and 42 lines. It will thus be seen, that the girth of the right ventricle was  $\frac{1}{3}\frac{1}{5}$  greater than that of the left, and the length of the cavity of the right ventricle 1·4th greater than that of the left. The capacity of all the orifices was above the average, and the pulmonic exceeded the aortic aperture by 1·6th, and the mitral exceeded the aortic by 1·3d, while the tricuspid orifice was, as usual, one-half larger than the aortic. A comparison of the dimensions of the heart in females in the



cases of bronchitis, with those of the healthy organ, shows similar results, but in only one case did the walls of the right ventricle attain a thickness of 4 lines, and in this instance there was chronic bronchitis with curvature of the spine, and the subject was 25 years of age.

The fossa of the foramen ovale in cases of chronic bronchitis, becomes considerably enlarged, and the valve is not unfrequently dilated and protruded into the left auricle. In one case, of which I have the preparation, a large sac is thus produced. When the fossa is dilated, the portion of the fold which ordinarily overlaps the isthmus is frequently drawn down, so that it may be found scarcely to reach above the edge of the opening; and when the valve has not become adherent the aperture might so be reopened; but, though I have seen several cases of very enlarged fossa with an unadherent valve, I have never met with one in which the foetal aperture was restored.

Though the disproportion between the size of the right and left ventricles of the heart, and especially the greater size of the pulmonic than of the aortic aperture, exists at all ages, except in very early life or before birth, and the experiments of Legallois have shown that is not dependent on the mode in which death takes place, it is certainly much aggravated in all cases in which there exists any obstruction to the transmission of the blood through the lungs. This is most marked in cases in which the obstruction has been of long duration; but I have seen the orifice of the pulmonary artery very considerably expanded in persons who have died of acute bronchitis and pneumonia, after short periods of illness.

#### 6. *Size of the heart in phthisis.*

In persons who have died of phthisis, the heart is usually smaller than in those who have sunk from other diseases; but the decrease in size is less than obtains in some other forms of disease, and is chiefly due to the diminution in the size of the cavities and in the capacity of the orifices, while both the right and left ventricles are thicker than in other chronic cases where there is no pulmonary disease.

The average circumference of the heart in males who died of phthisis was 94·5 lines, and the extremes 92 and 97.

The girth of the right ventricle averaged 49·5 lines, and its extremes were 49 and 50; that of the left ventricle had a mean of 45 lines, and extremes of 42 and 48.



The length of the right ventricle had an average of 43·3 lines, and extremes of 36 and 48 ; that of the left ventricle averaged 37·3, and its extremes were 36 and 39.

The walls of the right ventricle had a mean thickness of 2 lines ; those of the left ventricle, a mean of 6·3 lines, and extremes of 5 and 7 lines.

The right auriculo-ventricular aperture had a medium circumference of 49·3 lines, and extremes of 43 and 51. The pulmonic orifice a mean of 38·6 lines, and extremes of 29 and 48. The left auriculo-ventricular aperture a medium of 45·3, and extremes of 37 and 51 ; and the aortic aperture a mean of 34·6, and extremes of 26 and 42. It will thus be seen, that while the ventricular walls retain their usual thickness, or exceed it, the length of the cavities and the capacity of the orifices are much less than usual, and the difference is the more apparent when the dimensions of the heart in phthisis are compared with those of the organ in other chronic affections, unconnected with disease in the lungs. It will also be observed that the proportion between the cavities and orifices on the two sides of the heart is not materially different from that which obtains in the healthy organ ; the right side being, however, somewhat less than natural, relatively, to the left. As some of the results here deduced differ from those of M. Bizot, who states the heart in phthisis to be smaller in all its dimensions, it is right to state that the data here analysed are much fewer than those collected by that observer.

#### 7. *Dimensions of the heart in acute and chronic diseases.*

The observations are too few to warrant definite conclusions as to the different dimensions of the heart in persons who have died of acute and chronic diseases, but they would appear to indicate that the chief difference consists in the diminished thickness of the walls of the left ventricle.

#### *Comparison between the above conclusions and those arrived at by other observers.*

It will be observed, from the annexed statements (Table XII.), that though the series of observations collected by M. Bizot, Dr. Reid, Dr. Ranking, and myself, correspond to a considerable extent, there are differences between them. M. Bizot's measurements of the width of the walls are generally the least, those of Dr. Reid the largest. In the dimensions of the orifices, Dr. Ranking's observations show the smallest size, and Dr. Reid's the largest. The







TABLE XII. B.—Showing the mean dimensions of the heart according to the observations of M. Bizot, Dr. Reid, Dr. Ranking, and myself, in fractional parts of English inches.

	Bizot.		Dr. Reid.		Dr. Ranking.		Own Cases.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
	lines.	lines.	lines.	lines.	lines.	lines.	lines.	lines.
Circumference of the heart .....								
Girth of the right ventricle .....								
"    "    left .....								
Length of cavity of right ventricle .....	$3\frac{1}{2}$	3						
"    "    left .....	$3\frac{1}{2}$	$2\frac{3}{4}$						
Thickness of walls of right ventricle .....	$\frac{1}{2}$	$\frac{1}{2}$	$8\frac{1}{2}$	$\frac{7}{8}$	$9\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{1}{2}$	$9\frac{1}{2}$
"    "    left .....	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
"    "    septum .....	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Circumference of right auriculo-ventricular apert. ....	$4\frac{1}{2}$	$4\frac{1}{2}$	$5\frac{3}{4}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
"    pulmonic aperture .....	$2\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$
"    left auriculo-ventricular aperture .....	$4\frac{1}{2}$	$3\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$
"    aortic aperture .....	$2\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$

According to M. Bouillaud the mean circumference of the healthy heart in 10 males, from 16 to 38 years of age, is 105·37 lines; in 6 cases (4 males and 2 females) from 17½ to 45 years of age, in which he regards the organ as atrophied, 81·5 lines. Thickness of the walls of the left ventricle, 6½ to 7 lines; and 6½ lines; of the right ventricle, 2½ and 2½ths; of the septum, 7 lines; right auricle 1 line; left auricle, 1½ line; right auriculo-ventricular aperture, 46 and 47 lines; pulmonic aperture, 31½ and 28 lines; left auriculo-ventricular aperture, 42 and 40; aortic, 29½ and 28 lines.

Lobstein states the weight of the heart to be from 9 to 10 oz., and the dimensions as follows:—Length, 5 inches and 6 lines; breadth at base, 3 inches; thickness of the walls of the right ventricle, 2½ lines; of left ventricle, 7 lines; the right auricle, 1 line; the left auricle, half a line (French measures).

<sup>1</sup> Traité d'Anatomie Pathologique, tome ii. Paris, 1833, pp. 419 and 449.



TABLE XIII.—Showing the dimensions of the heart in males in cases of hypertrophy, unconnected with marked obstruction, in cases of obstruction at the aortic orifice or in the aorta, and in cases of incompetency of the aortic valves.

	Hypertrophy.				Obstruction at Aortic Orifice or in Aorta.			Incompetency of Aortic Valves.		
	Mean.	Lightest.	Heaviest.	lines.	Mean.	Lightest.	Heaviest.	Mean.	Lightest.	Heaviest.
	lines.	lines.	lines.	lines.	lines.	lines.	lines.	lines.	lines.	lines.
Circumference of heart.....	129	104	182	119.6	102	138	171	124.3	104	171
Girth of right ventricle .....	66.5	54	96	61.3	54	72	90	60.8	44	90
" left ventricle .....	62.5	50	86	58.3	48	66	81	63.5	60	81
Length of cavity of right ventricle .....	51.2	48	62	43	42	48	72	55.7	38	72
" left ventricle .....	45.7	40	51	38.8	36	42	60	45.4	38	60
Thickness of walls of right ventricle, base	2.2	2	3	2.3	3	2	2.5	2.32	2	2.5
" " midpoint	2.0	1.5	2.5	2.7	3	3	5	3.25	3	5
" " apex .....	1.7	1	2	1.5	2	1.5	2	1.82	1	2
" left ventricle, base	5.7	5	8	8.1	6	10	10	6.6	7	10
" " midpoint	8.5	7	11	8.06	8	11	11	6.7	7	11
" " apex.....	2.8	2	3.5	2.47	3	2.5	1	2.35	2.5	1
Thickness of septum.....	8.2	7	10	6.6		8		7.5	9	
Circumference of right auriculo-ventricular aperture .....	55.7	42	63	57.7	60	60	60	57.4	48	60
Circumference of pulmonary aperture.....	45	35	54	44.2	42	42	51	45.4	39	51
" of left auriculo-ventricular aperture .....	51.2	39	60	49.8	48	51	60	53.5	42	60
Circumference of aortic aperture .....	39.2	34	42	37.7	39	36	45	39	36	45

The cases of hypertrophy analysed in this table are four, in persons from 44 to 65 years, and with a mean age of 51 years. The hearts in the cases, weighed from 12 oz. 12 dr. to 40 oz. 12 dr., the mean weight being 21 oz. 4 dr.

The cases of obstruction are eight in number, in persons from 24 to 78 years of age, and with an average of 53.7. The weights of the heart range from 10 oz. 12 dr. to 21 oz., the mean being 15 oz. 2 dr.

The cases of incompetency are seven, the ages of the subjects from 32 to 57, the weights of the heart from 11 oz. 8 dr. to 34 oz., and the mean 19 oz. 3½ dr.



TABLE XIV.—Showing the dimensions of the heart in females, in cases of obstruction at the aortic orifice, of incompetency of the aortic valves, of mitral valvular disease, and of combined mitral and aortic valvular disease.

	Obstruction at Aortic Orifice.			Incompetency of Aortic Valves.	Mitral Valvular Disease.			Combined Mitral and Aortic Disease.		
	Mean.	Lightest.	Heaviest.		Mean.	Lightest.	Heaviest.	Mean.	Lightest.	Heaviest.
Circumference of heart .....	lines. 105.6	lines. 104	lines. 120	lines.	lines. 111.8	lines. 108	lines. 127	lines. 118	lines. 126	lines. 110
Girth of right ventricle.....	56	60	60		62.8	60	75	63.5	72	55
"    left ventricle .....	49.6	44	60		49	48	52	54.5	54	55
Length of cavity of right ventricle .....	42.3	39	48	52	46	42	51			43
"    left ventricle.....	37	39	42	52	39	36	42			42
Thick. of the walls of the right ventricle, base.....	2.16	25	2	2	2.2	2	2	2.6	2	2
"    "    "    midpoint .....	2.3	3	2	2	2.2	2	3	2.6	2	2
"    "    "    apex .....	2	2	2	1.5	1.3	1	1.5	2.1	1	1.5
"    left ventricle, base .....	6	5	5	6	5	4	5	7.3	6	7
"    "    "    midpoint .....	7.6	8	7	7	5.4	5	5	9	6	10
"    "    "    apex .....	2.8	3	2.5	3	2.2	2	2	2.6	3	2
Thickness of septum .....	5.5	6	5		5	4	5		5	
Circum. of right auriculo-ventricular aperture .....	57	54	60		51.2	57	54	48	42	51
"    of pulmonary aperture .....	36.5	34	39	39	34.6	39	39	35.6	36	32
"    of left auriculo-ventricular aperture .....	43.5	42	45		23	39	12	34.3	42	48
"    of aortic aperture .....	32.5	32	33	29	29	30	33	30.6	29	35

The cases of aortic valvular obstruction are only three in number, the subjects were 75, 75, and 60 years of age, and the hearts weighed 10 oz. 2 dr., 10 oz. 12 dr., and 14 oz. respectively.

In the single case of incompetency of the aortic valves, the subject was 46 years of age, and the heart weighed 16 oz. The cases of mitral valvular disease are five in number, the ages of the subjects ranged from 23 to 68, and the mean age was 39.4, the hearts weighed from 8 oz. 8 dr. to 15 oz. 12 dr., the mean weight being 11 oz. 13½ dr. The cases of combined mitral and aortic valvular disease are three in number, the ages from 18 to 63, the mean being 40 years, the weights of the heart ranged from 13 oz. 8 dr. to 22 oz., and the mean weight was 19 oz. 2½ dr. The dimensions of two cases of combined disease in females, 11 and 12 years of age, included in the general table, are excluded from this table.



seat at which M. Bizot took the dimensions of the aortic and pulmonic orifices differed from that selected by Dr. Ranking, the former having measured the opening at the level of the free border of the valves, while the latter took the dimensions on the line of their insertions; the precise point measured by Dr. Reid is not mentioned. All three observers estimate the circumference of the orifices after they had been laid open, whereas my own measurements were made while the apertures were entire by graduated balls passed through them, and therefore indicate their absolute capacity. After division the fibrous ring of the arterial orifices, especially that of the pulmonary artery, contracts, and it becomes extremely difficult or impossible, to judge of the size which should be assigned to the opening. The modes in which the length of the cavity of the right ventricle is estimated by M. Bizot and myself, also differs; his measurements refer to the length of a line from the base to the apex; mine, to that of a line following the course of the ventricle from the orifice of the pulmonary artery to the apex. It will be seen that the relative size of the heart in males and females in these tables differs but little, much less than is the case in the other observations. This is explained, as before mentioned, by the female hearts measured being, almost all of them, those of persons who had died of acute diseases, while the majority of the male hearts were from cases of chronic disease.

#### PART IV.—DIMENSIONS OF THE DISEASED HEART.

##### INFERENCES.

##### 1. *Hypertrophy not connected with valvular disease.*

The heart attained the greatest increase of size in the cases in which the hypertrophy and dilatation were unconnected with any marked disease of the valves or aorta, and the enlargement in these instances was not confined to the left cavities, but involved, though to a less degree, those of the right side also.

##### 2. *Obstructive disease of aortic valves.*

In the cases of obstructive disease of the aortic valves or of the aorta the heart was also very greatly enlarged, and the enlargement involved both the left and right cavities of the organ, but was not so great as in the cases of hypertrophy unconnected with valvular or aortic disease. The increased size was also by no means proportionate to the amount of impediment to the circulation, being in some cases very great where the obstruction was only trivial, and in others slight where very great obstruction existed.



### 3. *Regurgitant disease of aortic valves.*

In the cases of incompetency of the aortic valves, the capacity of the left ventricle was greater than either in the cases of simple hypertrophy or of obstructive disease, but the walls of the ventricle were usually less increased in thickness than in those diseases. The hypertrophy involved both sides of the heart, but the right ventricle attained a greater thickness in this, than in either of the other forms of disease.

It will be seen from the table of dimensions of the diseased heart in males, that the circumference of the organ averaged in the cases of hypertrophy, obstructive disease, and incompetency, respectively, 129, 119, and 124 lines, and attained the extremes of 182 lines, or 15 French inches, or 16 English ; 138 lines, or  $11\frac{1}{2}$  French inches, or about 12 inches English ; and 171 lines, or  $14\frac{1}{4}$  French inches, or about 15 English. The girth of the right ventricle measured externally averaged, in cases of hypertrophy, 66 lines, of obstructive disease 61 lines, and of incompetency 60 lines, and attained the extremes of 96, 72, and 90 lines. The girth of the left ventricle averaged in three several forms of disease 62, 58, and 63 lines, and attained the extremes of 86, 66, and 81 lines.

The length of the cavity of the right ventricle averaged in the three several forms of disease 51, 43, and 55 lines, and attained extremes of 62, 48 and 72 lines ; the length of the left ventricle averaged 45, 38 and 45 lines, and the extreme lengths were 51, 42 and 60 lines. The walls of the right ventricle, measured at the thickest part, were 2·2 lines in width, in cases of hypertrophy, 2·7 lines in cases of obstructive disease, and 3·25 in cases of incompetency ; and their minimum and maximum thickness in these several forms of disease were 2 and 3 lines, 3 lines, and 3 and 5 lines. The walls of the left ventricle averaged in width in cases of hypertrophy 8·7 lines, in obstructive disease 8·1 lines, and in incompetency 6·7 lines, and the extremes were respectively 7 and 11 lines, 6 and 11 lines, and 6 and 10 lines.

The septum had an average thickness in the cases of hypertrophy of 8 lines, and its extremes were 5 and 10 lines : in the cases of obstructions of 6·6 lines, and its extremes 6 and 8 ; and in the cases of incompetency, in the only two cases in which it was measured, it was 6 and 9 lines thick.

The capacity of the orifices in these diseases varied according to the form of the affection. In the cases of hypertrophy they



were all above the healthy standard. The aortic orifice averaged 39 lines in circumference, and its extreme dimensions were 34 and 42 lines. The left auriculo-ventricular aperture averaged 51 lines, and its extremes were 39 and 60 lines. The pulmonic aperture averaged 45 lines, and ranged from 35 to 54 lines, and the right auriculo-ventricular aperture averaged 55 lines, and ranged from 42 to 63 lines.

In the instances of obstructive disease the aortic orifice was in some cases greater, in others less, in circumference than natural. Its average capacity was 37 lines, and its extreme dimensions 33 and 42 lines, and all the other apertures exceeded the natural size. The mitral orifice averaged 49, and ranged from 48 to 54 lines, the pulmonic averaged 44 lines, and ranged from 42 to 48, and the tricuspid averaged 57, and ranged from 54 to 60 lines.

In cases of incompetency of the valves the capacity of the aortic orifice also varied with the nature of the disease, in some instances the valves being healthy, but incapable of closing the aperture from the amount of dilatation ; while in others the capacity of the aperture was not greater than natural, but the valves being diseased, were incapable of closing it. The mean circumference of the orifice in these cases was 39 lines, and it ranged from 30 to 45 lines ; but in the case in which the capacity of the orifice was only 30 lines, the incompetency was the result of laceration of the valves, from violent muscular exertion, and as there was no reason to suspect the existence of any disease of the heart before the occurrence of the accident, it is probable that the aperture had contracted, so as to afford some compensation for the imperfection of the valves. In these cases the capacity of all the other orifices was above the healthy standard, the mitral had a mean circumference of 53 lines, and its extreme dimensions were 42 and 60 lines, the pulmonic a mean of 45, and extremes of 59 and 51 lines, and the tricuspid a mean of 57, and extremes of 48 and 60 lines.

The auricles were greatly enlarged in all three forms of disease, and their walls generally increased in thickness ; the right auricle being from  $1\frac{1}{2}$  to 2 lines thick, the left from  $1\frac{1}{2}$  to 2 or  $2\frac{1}{2}$  lines. The coronary arteries, when measured, were also found above their natural size.

Though the walls of the left ventricle did not exceed 11 lines or about one English inch in thickness, in any of the cases included in the table ; in another instance, in a man 74 years, in which there



was some valvular thickening with dilatation of the aorta, the organ attained the weight of 19 oz. 8 dr., and the left ventricle near the base measured 14 lines, or nearly an inch and a quarter English. The cases included in the table, also, do not afford evidences of the extent to which the aortic orifice may be contracted; in one case, that of a female 75 years of age, which has before been several times alluded to, the aortic aperture was a mere slit 10 lines long, and the thickened and ossified valves did not admit of being separated for more than 3 or 4 lines; yet, though the disease probably originated in a congenital malformation of the valves, and had therefore very slowly advanced, the parietes of the left ventricle were only 8 lines in thickness, and those of the right 2 lines. In a case of obstructive and regurgitant disease of the aortic valves, not included in the tables, the septum had a width of 8·7 lines or  $\frac{3}{4}$  of an English inch.

The shape of the heart varies considerably in these different forms of disease, according to the seat and extent of the hypertrophy and dilatation. In cases of obstructive disease, whether the impediment be seated in the aortic valves or in the ascending portion of the aorta, the cavity of the left ventricle becomes peculiarly elongated, and the walls are ordinarily thicker near the base than elsewhere, and hence the whole organ has an acutely triangular form, and is much longer in its longitudinal, than in its transverse diameter. On the other hand, in cases of regurgitation through the aortic valves, while the left ventricle is elongated, the thickening of the parietes is more equably distributed throughout the cavity, and the apex, instead of being pointed, is obtuse, and thus the heart assumes a more oblong form, of which, however, the longest diameter is the longitudinal. In cases of regurgitation through the mitral aperture, and where there is considerable disease both of the mitral and aortic valves, the left ventricle, instead of being elongated, is expanded laterally, and especially at the apex, so that the organ has a more obtusely triangular form, and is generally broader from side to side than longitudinally. In these forms of disease, the right ventricle though implicated to a greater or less degree, is not so much so as to affect the shape of the heart generally, but in cases of obstructive disease of the mitral valve, the left ventricle, as will be shown more particularly below, is little if at all altered in dimensions, while the right ventricle is hypertrophied and very greatly dilated; and hence the organ, though not very greatly larger than natural, is much broader, and is very obtuse at the apex. These differences of form



are so striking and peculiar, that in many cases of diseased heart, it is easy to predicate before the cavities are laid open, the nature of the affection which will be found.

4. *Contraction of left auriculo-ventricular aperture.*

In cases of contraction of the left auriculo-ventricular aperture, uncomplicated with disease of the other orifices, the heart does not attain so great an increase of size as in the forms of disease before mentioned, for the enlargement is chiefly limited to the right cavities. Indeed, in some cases, more especially in young subjects, the capacity of the left ventricle, the thickness of its walls, and the circumference of the aortic orifice are found not at all to exceed the natural dimensions, or even to fall below the healthy standard.

It will be observed, that the comparison between the cases of mitral valvular disease and of obstructive disease, in females, would lead to the conclusion, that the heart in the latter disease is smaller than in the former; but this is doubtless an erroneous inference, founded upon the smallness of the number of cases of obstructive disease in females. A more correct impression is most probably to be gained by comparing the dimensions of the heart in cases of mitral valvular disease in females, with its size in the other form of disease in females;—for though the heart does not in any disease attain so great a size in females as in males, the general effect of different forms of disease on its nutrition may be inferred to be similar in the two sexes. The average circumference of the heart in the cases of mitral valvular disease, given in the table, will be seen to have been only 111 lines, and in no case did the circumference exceed 127 lines or  $10\frac{1}{2}$  French, or upwards of 11 English inches. The girth of the right ventricle averaged 62 lines, and in one case amounted to 75 lines. The girth of the left ventricle was very much less than that of the right, or only 49 lines on the average, and in no case more than 52 lines. The length of the right ventricle was on the average 46 lines, and its greatest length was 51 lines. The average length of the left ventricle was 39, and the extreme length 42 lines. The walls of the right ventricle averaged 2.2 lines in thickness, and ranged from 2 to 3 lines: those of the left ventricle had an average thickness of 5 lines, and ranged from 4 to 6 lines.

The mitral aperture varied considerably in the amount of contraction. In two cases, one of which is not included in the tables, it only admitted a cylinder 11 lines in circumference; in a third



instance its circumference was only 18 lines, and in three others it was 22, 24, and 39 lines, the mean being 23 lines. The aortic orifice was also below the natural size, or on the average only 29 lines in circumference, and its dimensions ranged from 25 to 33 lines.

The orifices on the right side of the heart were, on the contrary, ordinarily larger in comparison. The pulmonic aperture averaged  $34\frac{1}{2}$  lines in circumference, and ranged from 29 to 39 lines; the tricuspid averaged 51 lines, and ranged from 40 to 57 lines. The left auricle was in all the cases greatly dilated, and its walls varied in thickness from  $1\frac{1}{2}$  to 2 lines; the right auricle was generally still more enlarged, and its walls had a width of from 1 to  $1\frac{1}{2}$  lines.

It will thus be seen that, while the left ventricle and aortic orifice were below the healthy standard, the dimensions of the other parts of the organ exceeded the usual size, so that it may be inferred that the operation of this form of disease is either to cause atrophy of the left ventricle, or, when the disease commences in early life, to prevent the full development of that cavity. It will also be observed that the hypertrophy of the right ventricle did not, in any cases of mitral valvular disease, equal that which was found in the two cases of chronic bronchitis with curvature of the spine.

5. *Regurgitation through the left auriculo-ventricular aperture.*

The tables contain only one case of regurgitation through the left auriculo-ventricular aperture, from dilatation of the orifice without disease of the valves; and in this the subject was a child eight years of age, so that it cannot be compared with the other cases; allowance, however, being made for the age of the patient, the heart was much more enlarged than in the cases of mitral valvular contraction, and the left ventricle also was increased in size.

6. *Combined aortic and mitral valvular disease.*

In the cases in which both the aortic and mitral valves were diseased, the dimensions of the heart were intermediate between those in cases of uncomplicated mitral and aortic disease. The enlargement, instead of being chiefly limited to the right ventricle, involved the left also; and the length of the cavities and the thickness of the walls, were greater than in cases of mitral disease alone, but less than in cases of aortic disease.

The girth of the right ventricle in two of the cases in the table was 72 and 55 lines; of the left ventricle 54 and 55 lines. The mean thickness of the parietes of the right ventricle was 2.6 lines,



and the extremes 2 lines and 4 lines ; the mean width of the walls of the left ventricle was 9 lines, and the extremes 6 and 11 lines. In the only case in which the width of the septum was measured, it was 5 lines. In these instances the subjects were female, but I have notes of other cases of combined aortic and mitral disease in males. The subject of one of these, 36 years of age, and the heart weighed 17 oz. 8 dr. ; the dimensions are not given in the tables. The aortic valves were incompetent, and the mitral aperture so contracted as only to admit the handle of a scalpel, indicating a circumference of about 12 lines. The cavity of the right ventricle was 42 lines long, the left 37 lines. The walls of the right ventricle had a width of from  $4\frac{1}{2}$  to  $5\frac{3}{4}$  lines, and the left ventricle of  $5\frac{3}{4}$  at the base and midpoint, and  $3\frac{1}{2}$  near the apex. The longitudinal diameter of the heart was 42 lines, the transverse 54 lines. The walls of the right auricle averaged  $1\frac{1}{2}$  lines in thickness, those of the left auricle 2 lines. In a second case the subject was a boy 18 years of age, and the disease was the sequence of rheumatism four years before. The organ weighed 16 oz. The pericardium was adherent, and both the aortic and mitral valves were thickened and incompetent. The circumference of the heart measured 122 lines. The cavity of the right ventricle was 27 lines in length, the left 48 lines. The walls of the right ventricle measured 3 lines in thickness, those of the left 8 lines. The aortic orifice had a capacity of 42 lines, the mitral of 45, the pulmonic of 42, and the tricuspid of 54. The longitudinal diameter of the heart was 42 lines, the transverse 56 lines.

7. *Combined obstruction of right and left auriculo-ventricular apertures.*

Only one case of combined obstruction of the right and left auriculo-ventricular apertures is included in the tables ; and in this instance the most remarkable feature was the great degree of contraction which existed in both openings, the left auriculo-ventricular aperture having a circumference of only 18 lines, and the right of only 21 lines ; yet with this very great amount of obstruction, which had probably commenced before birth, the walls of the right ventricle were only 1.5 lines in width, and those of the left ventricle 4 lines. The right auricle was very greatly dilated, and its walls were from  $\frac{1}{2}$  a line to 2 lines in thickness ; the right ventricle was somewhat dilated. The left auricle was also dilated, and the left ventricle, though to a less degree. The aortic orifice measured 30 lines in circumference, the pulmonic 35 lines. The



aortic valves were also thickened and adherent. The subject of the case was a female 37 years of age.

8. *Dimensions of the heart in cases of malformation.*

The dimensions of the heart in cases of malformation vary with the kind of the deviation from the natural structure. The most frequent form of irregular development is that in which the pulmonary orifice is contracted, and the septum ventriculorum imperfect, or the foramen ovale open. Three cases of this description are included in the tables. The subjects were males, 15 and 20 years of age, and a female 19 years old. In the first case the pulmonary artery was so contracted, as only to give passage to a ball 13 lines in circumference, in the second of 12 lines, and in the last of 8 lines. In the first and third cases the aorta arose from both ventricles, in the second the foramen ovale was open. In each of these cases the right ventricle was very greatly hypertrophied, measuring 54, 66, and 84 lines in circumference externally, while the left ventricle had only a girth of 42, 42, and 48 lines. The walls of the right ventricle measured  $5\frac{1}{2}$ , 7, and 4 lines, those of the left ventricle  $4\frac{1}{2}$ , 6, and 6 lines. It will thus be seen that, though the enlargement was chiefly on the right side, allowance being made for the age and sex of the subjects, the left ventricle must also have partaken of the hypertrophy; and this is still more obvious in cases of malformation in younger persons. The auricles were also greatly dilated and hypertrophied, measuring from  $1\frac{1}{2}$  to 2 or  $2\frac{1}{2}$  lines.

In another instance in which malformation of a similar description was found in a child  $6\frac{1}{2}$  years old, the pulmonary orifice only admitted a cylinder  $6\frac{1}{2}$  lines in circumference; and in a fifth, in an infant 2 years and 5 months old, it was a mere slit 2 lines long. In these cases the walls of the right ventricle were much hypertrophied, measuring in each case, at the thickest point, 4 lines; while the left ventricle measured in the former case 6 lines, in the latter 3; and the density and resistance of the walls of the right ventricle, as in all the other cases of this kind of malformation, contrasted remarkably with the flaccidity of those of the left ventricle.

The septum is not, in these cases, hypertrophied in proportion to the walls of the right ventricle; indeed, that portion of the heart is more implicated in diseases of the left ventricle than in those of the right. Thus, while in cases of hypertrophy without valvular disease and in others of obstructive disease it had a thickness nearly



equal to that of the outer walls of the left ventricle, or of from 9 to 10 and 11 lines;—in the cases of malformation in which the parietes of the right ventricle were from 6 to 7 lines thick, or fully three times the natural width, the septum measured only 6 lines in thickness, or was not materially wider than usual.

Different opinions have prevailed as to the cause of the hypertrophy of the right ventricle in cases of malformation. It has been supposed to be due to the entrance of aerated blood into the right cavities of the heart; but this cannot be the true explanation, for, in the most remarkable cases of hypertrophy, the course of the blood must necessarily be from the right ventricle or auricle into the left. The more correct theory is, doubtless, that which ascribes the hypertrophy to the effort to overcome the obstacle to the flow of blood from the ventricle, through the contracted pulmonary orifice. Another cause, which would have a similar effect, obtains in many cases, and appears to have been overlooked. I allude to the increased action of the right ventricle consequent upon the aorta arising in part from that cavity, and the share which it consequently takes in the maintenance of the systemic circulation. In one of the cases of malformation which I have mentioned, while the parietes of the infundibular portion of the right ventricle, upon which the stress from the contracted pulmonary orifice would chiefly fall, had only an extreme width of 4 lines; those of the sinus, which were chiefly concerned in propelling the blood from the right ventricle into the aorta, were 7 lines in thickness. It is true that the walls of the sinus are ordinarily thicker than those of the infundibular portion of the right ventricle, but the difference is ordinarily much less considerable.

It has been thought that the condition of the right ventricle, in some cases of malformation, affords an exception to the general rule of the non-occurrence of true concentric hypertrophy; and specimens, when first removed from the body, and preparations preserved in museums, not unfrequently present the appearance of increased thickening of the walls of the right ventricle, with diminution of its cavity. These appearances, are, however, I believe, deceptive, and depend upon specimens being examined, or the preparations having been immersed in spirit, before the tonic contraction of the muscular fibres had subsided. I have seen cases of malformation in which, when the right ventricle was first laid open, there seemed to be absolutely no cavity, but in which, after maceration, the ventricle proved to be unusually large.



In cases in which the maintenance of the circulation is thrown upon the left ventricle, as when the right auriculo-ventricular aperture is obliterated, or when that opening or the pulmonary orifice is greatly contracted after the complete development of the septum of the ventricles, the left ventricle becomes much hypertrophied and dilated, while the right ventricle undergoes a proportionate decrease in size. In some of these cases, indeed, the right ventricle becomes reduced to a small hollow, about the size of a pea, which is surrounded by thick ventricular walls; but this condition is clearly one of atrophy, not of hypertrophy, and the defective nutrition of the muscular substance of the right ventricle from disuse, is shown by its unusual paleness and flaccidity, and by the looseness of its texture.

GENERAL REMARKS ON THE DIMENSIONS OF THE DISEASED HEART.—The changes which the heart undergoes in disease have attracted the attention of most systematic writers, and especially of Laennec, Bertin, Lobstein, Cruveilhier, and Hope; and I may particularly refer to the series of observations published by Bouillaud, and to the incidental allusions to the measurements of the organ in cases of disease, contained in Dr. Ranking's valuable paper. It may not be without interest to compare the observations of these writers with the results obtained from the analysis of the cases now published.

The circumference of the largest heart measured by M. Bouillaud was 12 French inches, and of that mentioned by Dr. Ranking  $12\frac{3}{4}$  English inches—dimensions which very nearly correspond. In my own tables the dimensions are given of the heart of a male in a case of hypertrophy without valvular disease, which measured 15 inches and 2 lines French, or somewhat above 16 English inches in circumference, and one of incompetency of the aortic valves, in which the circumference of the heart was 14 inches and 3 lines, or about 15 English inches. In females the extreme circumference of the heart was 10 inches and 7 lines, or about 11 English inches, in a case of mitral valvular disease, and 10 inches and 6 lines in one of combined aortic and mitral disease, and 10 inches in one of obstructive disease at the aortic orifice.<sup>1</sup>

The thickness of the walls of the right ventricle is stated by

<sup>1</sup> M. Bouillaud, for purposes of comparison, gives the weight and dimensions of the heart of an ox; the weight was 66 oz. 7 dr. avoird., and the circumference 18 French inches.



Laennec<sup>1</sup> rarely to exceed 4 or 5 lines; and in the observations of M. Bouillaud, no case is given in which it measured more than  $4\frac{1}{2}$  lines. Bertin,<sup>2</sup> however, describes a case in which there existed a congenital contraction of the orifice of the pulmonary artery from adhesion of the valves, with patency of the foramen ovale, in a female 57 years of age, and, in this instance, the cavity of the right ventricle was less than natural, and its walls from 16 to 11 lines thick. M. Burnet<sup>3</sup> relates a somewhat similar case of congenital disease, in which, however, the foramen ovale was closed, in a girl 7 years of age, in whom the walls of the right ventricle were nearly an inch in width, and the cavity almost obliterated; and Louis<sup>4</sup> has described a case of contraction of the pulmonary orifice with imperfection of the septum ventriculorum in a man 25 years of age, in whom the parietes of the right ventricle had a width of 8 to 10 lines. Hope, in cases of congenital obstruction of the pulmonic aperture with an open foramen ovale, in a girl 8 years of age, and of aneurism of the aorta with regurgitation through the aortic valves, in a man 25 years of age, found the walls of the right ventricle half an English inch, or  $5\frac{3}{4}$  lines thick. Dr. Ranking refers to a case in which the pulmonary artery was contracted and the foramen ovale unclosed; and to another, in which the aorta arose from both ventricles, with pulmonic valvular obstruction, in which the parietes of the right ventricle measured 17-48ths (about 4 lines), and 44-48ths (10 lines) of an English inch in thickness. In none of the observations now published were the walls of the right ventricle so extremely hypertrophied as in the cases last named. The greatest thickness of the parietes being 5 lines in a case of chronic bronchitis, with deformed spine, 5 lines in cases of obstructive disease, and of incompetency of the aortic valves,  $5\frac{3}{4}$  lines in a cases of combined mitral and aortic valvular disease, and 7 lines in cases of congenital obstruction at the pulmonic orifice, with a patent foramen ovale in one, and deficiency of the septum ventriculorum in the other. In the latter case the subject was a female, while in all the others they were males; with this

<sup>1</sup> Diseases of the Chest, 4th Ed. Forbes' Translation, 1834, p. 547.

<sup>2</sup> Maladies du Cœur. Paris, 1824, p. 326. Obs. 87. See also Bouillaud, Traité Clinique, 2me Ed., 1841, t. ii., p. 273. Obs. 126.

<sup>3</sup> Bouillaud, p. 281. Obs. 128; and Journal Hebd. de Méd., 1831.

<sup>4</sup> Mém. ou Recherches Anatomico-Pathologiques. Paris, 1826, p. 313. Obs. 10. See also Arch. Gén. de Méd., 2mo série, t. iii., 1823.



exception, the walls of the right ventricle did not exceed 4 lines in thickness in females, and the instances in which they attained this width were cases of combined aortic and mitral valvular disease, and of chronic bronchitis.

The parietes of the left ventricle are stated by Laennec to have been seen by him an inch, or even 18 lines thick, or double or triple the size in the sound state. This statement is repeated by Elliotson,<sup>1</sup> and Hope mentions, that the walls of the left ventricle may attain a thickness of one, one and a half, or, according to some, of two inches; and he mentions a case in which they were  $1\frac{1}{2}$  inches thick in a case of regurgitation through the aortic orifice. The extreme thickness of the parietes of the left ventricle in the cases mentioned by Bouillaud, is 13 lines. Of the hearts examined by Ranking, in one the walls of the left ventricle attained a width of one inch, or about  $11\frac{1}{4}$  lines, and Bertin mentions a case in which they were upwards of one inch in thickness.

The greatest width of the parietes of the left ventricle in the cases given in the present memoir, was in males 11 lines, in cases of hypertrophy without valvular disease, and of aortic disease, and of dilatation of the aorta with chronic bronchitis; but another case is referred to, in which there was slight valvular disease with dilatation of the aorta, and the parietes of the left ventricle measured 14 lines in width. In females the greatest thickness of the walls of the left ventricle was 10 and 11 lines, in cases of combined aortic and mitral valvular disease.

The septum of the ventricles is mentioned by M. Bertin to have been found by him one inch in thickness; the greatest width in M. Bouillaud's observations is 10 lines, and Dr. Ranking found it 38-48ths of an English inch (8.75 lines) in one case. In the present observations the greatest width in males is 10 and 11 lines in cases of hypertrophy without valvular disease, and 9 lines in cases of incompetency. In females the greatest width is 6 lines in a case of mitral valvular disease. I regret, that in the observations, the dimensions of the septum were less frequently obtained than would have been desirable.

The parietes of the right auricle were found by M. Bouillaud, in two cases, to measure 3 and  $3\frac{1}{2}$  lines in width, but his measurements are taken near the appendix, where ordinarily the walls are thicker

<sup>1</sup>Lumleyan Lectures.



than across the middle of the sinus. Bertin also examined a heart in which the walls of the right ventricle had a width of 3 lines ; and Dr. Hope speaks of a thickness of a quarter of an inch as occasionally seen. In my own observations, the walls of the right auricle attained a width of 3 lines in only one case, that of the female, 19 years of age, in whom congenital contraction of the pulmonary aperture and deficiency of the septum of the ventricles, was combined with some disease of the tricuspid valves. The parietes of the right auricle measured  $2\frac{1}{2}$  lines in a case of combined mitral and aortic disease, in a boy of 18 years of age, and attained the same thickness in a case of aneurism of the apex of the left ventricle, with open foramen ovale. They were also 2 lines thick in the case of great contraction of the mitral and tricuspid valves, and in one of combined aortic and mitral valvular disease.

The maximum thickness of the parietes of the left auricle, mentioned by M. Bouillaud, is  $2\frac{1}{2}$  lines. In my own observations its greatest width was two lines in cases of regurgitation through the left auriculo-ventricular aperture, obstructive and regurgitant disease of the mitral valves, combined aortic and mitral valvular disease, and regurgitation through the aortic aperture.

In the data collected by M. Bouillaud, the aortic aperture had a maximum capacity of 41 lines, and a minimum of 11 lines. Dr. Hope mentions a case in which it was contracted to the size of a small pea. Its circumference in one case, measured by Dr. Ranking, in a boy 18 years of age, was only one inch and 3-48ths (12 lines). In my own observations, its largest size, in males is 45 lines, and its least 30 lines in cases of regurgitation through the aperture. In females its greatest circumference was in a case of combined aortic and mitral valvular disease, in which it measured 35 lines, while in another case before referred to, it was reduced to a mere slit 10 lines in length, and the thickened and ossified valves did not admit of being separated for more than three or four lines.

The pulmonic aperture in the hearts measured by M. Bouillaud, had a maximum circumference of 42 lines, and a minimum of 34 lines. The extreme size of the orifice is not mentioned by Dr. Ranking in his observations ; but he gives two instances in which the aperture was contracted, as is almost always the case from congenital malformation, and in these the aperture measured one inch, and one inch and 40-48ths (rather more than 11 lines and 20·5 lines) in circumference. In the cases related by Bertin, Louis, and



Burnet, the aperture had a diameter of only  $2\frac{1}{2}$ ,  $2\frac{1}{2}$ , and  $1\frac{1}{2}$  lines. In the case quoted by Hope, the pulmonary orifice would only admit a goose quill, and in one related by Dr. Hunter, the pulmonary artery would only admit a small probe, though the patient was 13 years old. In the observations published in the paper, the largest size of the pulmonic orifice in males is 54 lines in a case of hypertrophy, unconnected with valvular disease; and in females 39 lines, in a case of mitral valvular disease. In the cases of malformation before mentioned, in males 15 and 20 years of age, and in the female 19 years of age, the aperture had a circumference of only 13, 12, and 8 lines; and in children  $6\frac{1}{2}$  years, and 2 years and 5 months old, it was only  $6\frac{1}{2}$  lines, and 5 lines in circumference.

The left auriculo-ventricular orifice in the cases of M. Bouillaud had an extreme capacity of 51 lines, and of 24 lines; but he mentions another case in which the aperture was so contracted as only to be 6 or 7 lines long and 5 lines wide, and two in which it was only 3 lines in its largest diameter, or 8 or 9 lines in circumference.<sup>1</sup> Dr. Ranking measured two hearts, in which the mitral orifice had a circumference of  $5\frac{1}{2}$  inches ( $61\frac{3}{4}$  lines), and 5 inches and 2-48ths (54 lines), and he found none in which it was less than two inches and 19-48ths (27 lines). In the present series of measurements, the extreme capacity of the left auriculo-ventricular aperture is in males 60 lines, in cases of hypertrophy without valvular disease, and incompetency of the aortic valves; and in females 45 lines in a case of obstruction at the aortic orifice. Its smallest size is in males, in a case of combined disease of the aortic and mitral valves, in which it would only admit the handle of a small scalpel, and had a circumference of not more than 12 lines. In females its smallest circumference was 12 and 18 lines, in cases of uncomplicated mitral valvular disease.

The right auriculo-ventricular aperture in the observations of M. Bouillaud had an extreme capacity of 69 lines, and the only case of contraction of this aperture to which he refers, is that of General Whiple,<sup>2</sup> in which there was an opening one inch long and one line wide. Laennec does not refer to any case of extreme contraction of the tricuspid aperture; but Dr. Forbes, in a note to his translation,<sup>3</sup>

<sup>1</sup> Observations 112, 116, and 117.

<sup>2</sup> Journal de Médecine et de Chir. Par MM. Corvisart, Leroux, etc. Vol. xix., p. 468.

<sup>3</sup> Page 590, 4th Ed., 1834.



mentions one in which the aperture would only admit the thumb, and in which, like one I have before referred to, the mitral and the aortic apertures were also contracted. In the case related by M. Louis, contraction of the tricuspid aperture was also, as frequently happens, combined with the disease of the pulmonic valves. Dr. Ranking measured a heart in which the right auriculo-ventricular aperture had a circumference of  $6\frac{1}{2}$  English inches, or somewhat more than 73 lines. He does not refer to any cases of contraction. In the present series, the largest circumference of the tricuspid aperture in males is 63 lines and 60 lines, in cases of hypertrophy without valvular disease, and 60 lines in cases of obstructive disease, and incompetency of the aortic valves. In females the greatest circumference is 60 lines in a case of obstructive disease, and 57 lines in one of uncomplicated mitral valvular disease. The most extreme degree of contraction of this aperture with which I have met, was in a case of combined aortic, mitral, and tricuspid disease, not mentioned in the tables, in a female 32 years of age, in whom the tricuspid valves were adherent, so that the aperture would only admit the point of the forefinger, indicating a circumference of about 16 lines. The case of a similar kind mentioned in the paper, the aperture was 21 lines in circumference. Elsewhere I have expressed the opinion, that the disease of the valves in these cases, like the similar fusion of the valves of the pulmonary artery, is due to intra-uterine disease, and that they are, therefore, to be regarded as malformations.<sup>1</sup>

In reviewing the communication, it will be seen that the conclusions drawn from the data collected, correspond generally with those of other observers, so far as relates to the weight and dimensions of the healthy heart; but in reference to the diseased organ, they present several differences which are not without interest. They show that the heart may attain a weight and size much larger than was previously supposed, and that the greatest amount of enlargement may be found when there is no material valvular disease, or any other obvious source of obstruction to which it can be referred. They indicate, also, a general relation between the dimensions and weight of the heart, and the different forms of disease of which it may be the seat, or in which it may be indirectly implicated. This connection, so far as I am aware, has not been previously clearly

<sup>1</sup> See Lectures on Malformations.—London Medical Times and Gazette, 1854.



pointed out ; but if, as I feel much confidence in believing, the conclusions here arrived at, should prove on more extended investigation to be of general application, they must be admitted to be not only of much pathological interest but also of practical importance.



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