THE NUMBER OF FORMED ELEMENTS IN THE URINARY SEDIMENT OF PATIENTS SUFFERING FROM HEART DISEASE, WITH PARTICULAR REFERENCE TO THE STATE OF HEART FAILURE

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It is well known that casts, red blood cells and white blood cells may be present in the urinary sediment of patients suffering from heart failure. In the manner that specimens of urine are usually obtained it is not possible to gain an accurate notion of the numbers of cells which are present, since variations in salt concentration and reaction of the urine may result in partial or complete disappearance of the formed elements of the urine. Addis (1) recommended a procedure which has for its object the secretion by the kidneys of urine of such high specific gravity and acidity that the integrity of the formed elements of the urine is maintained. By this means the number of elements in urinary sediment formed in a 12-hour period may be estimated. Addis (2) found that the number of casts passed in a 12-hour period varied in normal individuals between 0 and 4,270, the average being 1,040; the number of red blood cells between 0 and 425,000, the average being 65,700; the number of white blood and epithelial cells between 32,400 and 1,835,000, the average being 322,500. The casts were hyaline; granular casts were not observed.

The present study is concerned with the estimation of the number of formed elements in the urines of patients suffering from chronic heart disease, especially of the so-called arteriosclerotic type, more particularly with reference to the state of heart failure of the congestive type.

The patients were at rest in bed and were in water equilibrium. Observations were made in patients suffering from the congestive type of heart failure, and again in the same patients after the signs and symptoms of heart failure had disappeared. In others, observa-
tions could be made only during the stage of decompensation, while in others still, only after the return to the state of compensation. In addition there are data in a few patients who had never suffered from heart failure. Most of the patients were males; catheterization of females is necessary if accurate counts of the cells are desired. The sediment was studied according to the technique described by Addis (1). The procedure begins after breakfast. The patient is given no fluid following this meal until after the end of the test the next morning (6 a.m.). The patient voids at 6 p.m.; this specimen is discarded. The total night urine (6 p.m.–6 a.m.) is obtained at one voiding 12 hours later. The casts, red blood and white blood cells are counted in samples of this specimen.

**OBSERVATIONS**

The number of formed elements in the urine in the presence of heart failure of the congestive type. In 18 patients (tables 1 and 2), the number of casts in 12-hour samples varied between 0 and 463,740, the average number being 66,485 (table 3). In 6 instances the number was within the normal range (4 none, 2 high) and in the 12 remaining, greater than the highest normal value observed by Addis (2). Granular casts were found in approximately half the urines. The red blood cell counts ranged from 72,210 to 3,090,000, the average being 834,754. In 9 patients the number was normal (1 average, 8 high) and in the 9 remaining greater than the highest normal value. The white blood and epithelial cells varied between 70,000 and 17,877,000, the average being 3,089,302. In 13 patients the range was normal (1 average, 12 high), and in the 5 remaining greater than the highest normal value.

In the presence of heart failure of the congestive type, therefore, the number of casts was definitely increased in approximately two-thirds of the cases studied, the red blood cells increased in approximately one-half, and the white blood cells in approximately one-third. The average number of casts was 60 times and the average number of red blood cells and of white blood cells 10 to 15 times greater than in normal subjects.

The number of formed elements in the urine following recovery from cardiac decompensation. After recovery from heart failure in 16 patients the number of casts varied between 0 and 141,000 (tables 1
and 4), the average being 34,600 (table 3). In 4 instances the number was normal (4 none) and in 12, greater than normal. Granular casts were found in approximately 25 per cent. Red blood cells varied between 165,000 and 3,090,000, the average being 917,515. In 4 patients the number was normal (4 high) and in 12, greater than the highest normal value. The white blood and epithelial cells ranged between 304,000 and 2,520,000, the average being 1,151,187. In 13 patients the range was within normal limits (2 average, 11 high) and in 3, greater than the highest normal value.

In our experience, it appears therefore to be a fact that approximately 75 per cent of the patients who had recently recovered from heart failure of the congestive type passed in their urines a greater number of casts than normal individuals, an increased number of red blood cells, but in the case of white blood cells a number greater in one-fourth of the patients than the highest number in normal individuals.

Comparison of the numbers of formed elements present in the urine during heart failure and following recovery. When observations (11 patients) were possible during the stage of heart failure as well as after return to compensation (table 1), we found no fixed tendency of direction; that is to say, the casts, red blood cells and white blood cells were as frequently increased following the disappearance of signs of heart failure as they were decreased (see discussion). On comparison of the average numbers (table 3), however, it appears that casts and white blood cells were passed in approximately twice the quantity during decompensation as after recovery, but the red blood cells in approximately the same numbers.

The number of formed elements in the urine of patients who have not suffered from heart failure of the congestive type. In 7 cardiac patients who had not suffered from heart failure (table 5) the number of casts ranged from 0 to 80,000, the average being 17,792 (table 3). In 4 individuals, the range was normal (2 none, 2 high) and in 3, greater than the highest normal value. In approximately half the patients granular casts were found (table 5). The red blood cells varied between 22,250 and 428,000, the average being 162,531. In all instances the count was within the normal range. The white blood cells varied between 96,000 and 1,788,000, the average being 809,555. In each case the range was normal.
<table>
<thead>
<tr>
<th>Case number</th>
<th>Hospital number</th>
<th>Sex and age</th>
<th>State with reference to heart failure</th>
<th>Diagnosis*</th>
<th>Etiological</th>
<th>Anatomical</th>
<th>Pb;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7106</td>
<td>M. 40</td>
<td>During failure (+++++)†</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy, mitral insufficiency, chronic myocarditis</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7054</td>
<td>M. 47</td>
<td>During failure (+++)</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy, mitral insufficiency, chronic myocarditis</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7255</td>
<td>M. 74</td>
<td>During failure (+)</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7318</td>
<td>M. 68</td>
<td>During failure (++)</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy, chronic myocarditis, VPL§</td>
<td>Norm</td>
<td>C.I.</td>
</tr>
<tr>
<td>5</td>
<td>7108</td>
<td>M. 60</td>
<td>During failure (+)</td>
<td>Arteriosclerosis</td>
<td>Chronic myocarditis</td>
<td>Norm</td>
<td>C.I.</td>
</tr>
<tr>
<td>6</td>
<td>6784</td>
<td>F. 40</td>
<td>During failure (++++)</td>
<td>Hypertension, 180/130</td>
<td>Cardiac hypertrophy, mitral insufficiency, aortic roughening, VPL</td>
<td>Norm</td>
<td>I-E</td>
</tr>
<tr>
<td>7</td>
<td>4692</td>
<td>M. 58</td>
<td>During failure (+++)</td>
<td>Arteriosclerosis, hypertension</td>
<td>Cardiac hypertrophy, mitral insufficiency, chronic myocarditis</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>7091</td>
<td>M. 34</td>
<td>During failure (++++)</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral stenosis, mitral insufficiency, aortic roughening</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>7325</td>
<td>M. 34</td>
<td>During failure (+)</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral stenosis</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>7223</td>
<td>M. 27</td>
<td>During failure (++)</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral insufficiency and stenosis, aortic roughening</td>
<td>Arrixxation</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>7311</td>
<td>M. 40</td>
<td>During failure (++++)</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral insufficiency and stenosis</td>
<td>Arrixxation</td>
<td></td>
</tr>
</tbody>
</table>

* The diagnoses in this table as well as in tables 2, 4 and 5 conform to the nomenclature for cardiac dial.
† The degree of heart failure is indicated by + signs in this table as well as in tables 2 and 4.
‡ In this table as well as in tables 2 and 4, + and 0 indicate the presence or absence of the sign.
§ VPL = left ventricular preponderance in this table as well as in tables 2, 4 and 5.
C.H.F. = heart failure of the congestive type in this table as well as in tables 2, 4 and 5.
I-HB = incomplete heart block in this table as well as in tables 2, 4 and 5.
<table>
<thead>
<tr>
<th>Physiological signs of heart failure</th>
<th>Signs of heart failure†</th>
<th>Medication effective in relief of heart failure</th>
<th>Urine clearance</th>
<th>Plasma leucocytosis in 2 hours</th>
<th>Sediment test (Addis)</th>
<th>Casts</th>
<th>Red blood cells in 12 hours</th>
<th>White blood cells in 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edema</td>
<td>Hydrothorax</td>
<td>Rales</td>
<td>Cyanosis</td>
<td>Ascites</td>
<td>Digitalis and theocalcin</td>
<td>Digitalis</td>
<td>Digitalis</td>
<td>2 Digitalis</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids and fluids in bed</td>
<td>93 74</td>
<td>0 292,500 1,023,750</td>
<td>91,400 75 1,050,000 2,520,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>1 Digitalis</td>
<td>64 54</td>
<td>23,800 67 33 98,000</td>
<td>70,000</td>
<td>55 59</td>
<td>65,920 67 33 3,090,000</td>
<td>834,000</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>62 36</td>
<td>9,240 100 165,000</td>
<td>577,000</td>
<td>67 53</td>
<td>59,400 25 674,000 1,215,000</td>
<td>4,890 99 1 208,000 1,300,000</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>58 53</td>
<td>33,200 66 33 300,000</td>
<td>800,000</td>
<td>57 53</td>
<td>50 50 904,500 1,056,000</td>
<td>4,890 99 1 208,000 1,300,000</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>97 48</td>
<td>10,080 100 156,800 1,232,000</td>
<td>10,080 100 156,800 1,232,000</td>
<td>107 72</td>
<td>11,220 100 105,000 1,056,000</td>
<td>107 72</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>160 62</td>
<td>141,600 100 480,000 2,257,500</td>
<td>141,600 100 480,000 2,257,500</td>
<td>160 62</td>
<td>141,600 100 480,000 2,257,500</td>
<td>160 62</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>95 54</td>
<td>72,000 100 99,450 5,670,000</td>
<td>72,000 100 99,450 5,670,000</td>
<td>95 54</td>
<td>72,000 100 99,450 5,670,000</td>
<td>95 54</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>77 67</td>
<td>16,400 100 157,000 2,201,000</td>
<td>16,400 100 157,000 2,201,000</td>
<td>77 67</td>
<td>16,400 100 157,000 2,201,000</td>
<td>77 67</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>29 53</td>
<td>3,905 50 50 585,750 461,500</td>
<td>3,905 50 50 585,750 461,500</td>
<td>29 53</td>
<td>3,905 50 50 585,750 461,500</td>
<td>29 53</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>32 53</td>
<td>19,740 100 705,000 1,938,750</td>
<td>19,740 100 705,000 1,938,750</td>
<td>32 53</td>
<td>19,740 100 705,000 1,938,750</td>
<td>32 53</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>113 61</td>
<td>151,060 66 1,356,000 2,947,500</td>
<td>151,060 66 1,356,000 2,947,500</td>
<td>113 61</td>
<td>151,060 66 1,356,000 2,947,500</td>
<td>113 61</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>12,600 100 1,462,500 1,912,500</td>
<td>0 1,402,500 627,500</td>
<td>0 1,402,500 627,500</td>
<td>12,600 100 1,462,500 1,912,500</td>
<td>12,600 100 1,462,500 1,912,500</td>
<td>12,600 100 1,462,500 1,912,500</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>31,350 50 50 1,140,000 1,425,000</td>
<td>0 1,402,500 627,500</td>
<td>0 1,402,500 627,500</td>
<td>31,350 50 50 1,140,000 1,425,000</td>
<td>31,350 50 50 1,140,000 1,425,000</td>
<td>31,350 50 50 1,140,000 1,425,000</td>
</tr>
<tr>
<td>+ + + + + + + + + + + + + + + + +</td>
<td>0 0 0 0 0 0 0</td>
<td>1 Limitation of fluids in bed</td>
<td>62,150 33 66 706,250 706,000</td>
<td>0 1,402,500 627,500</td>
<td>0 1,402,500 627,500</td>
<td>62,150 33 66 706,250 706,000</td>
<td>62,150 33 66 706,250 706,000</td>
<td>62,150 33 66 706,250 706,000</td>
</tr>
</tbody>
</table>

### Table 2

The number of formed elements found in the urine during heart failure of the congestive type

<table>
<thead>
<tr>
<th>Case number</th>
<th>Hospital number</th>
<th>State with reference to heart failure</th>
<th>Etiological</th>
<th>Anatomical</th>
<th>Physiological</th>
<th>Signs of heart failure</th>
<th>Sediment test (Addia)</th>
<th>Urea clearance</th>
<th>Casts</th>
<th>Hemat. Granular</th>
<th>Red blood cells in 12 hours</th>
<th>White blood cells in 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>7078</td>
<td>During failure (+++++)</td>
<td>Arteriosclerosis, hypertension</td>
<td>Cardiac hypertrophy, aortic roughening</td>
<td>Normal rhythm, C.H.F.*</td>
<td>++++++++ 1</td>
<td>36,080 100 100 451,000 6,478,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>7184</td>
<td>During failure (+++++)</td>
<td>Arteriosclerosis, hypertension</td>
<td>Cardiac hypertrophy, chronic myocarditis</td>
<td>Auricular flutter, C.H.F.</td>
<td>+0+++++ 1</td>
<td>144,375 90 10 393,750 656,250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>7110</td>
<td>During failure (+)</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy, chronic myocarditis, VPL</td>
<td>Normal rhythm, APC, VPC, C.H.F.</td>
<td>+000000 1 14 37 17,928 100 540,000 864,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>6911</td>
<td>During failure (++++)</td>
<td>Arteriosclerosis, rheumatic fever</td>
<td>Cardiac hypertrophy, mitral insufficiency, aortic roughening, VPL</td>
<td>Normal rhythm, VPC, C.H.F.</td>
<td>++++++++ 1 69 50 280,000 100 183,750 3,675,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>7085</td>
<td>During failure (+++++)</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral insufficiency, mitral stenosis chronic myocarditis, VPR*</td>
<td>Auricular fibrillation, C.H.F.</td>
<td>+++++++ 0 1</td>
<td>463,740 90 10 2,478,000 17,877,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>7323</td>
<td>During failure (++++)</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral stenosis and insufficiency, cardiac dilatation</td>
<td>Auricular fibrillation, C.H.F.</td>
<td>++++++++ 9 0 1,402,500 627,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>7222</td>
<td>During failure (++++)</td>
<td>Syphilis</td>
<td>Cardiac hypertrophy, aortic insufficiency</td>
<td>Normal rhythm, C.H.F.</td>
<td>++++++++ 1 70 89 29,925 100 72,210 4,132,250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* C.H.F. = heart failure of the congestive type
VPR = right ventricular preponderance
APC = auricular premature contractions
VPC = ventricular premature contractions

In this table as well as in table 4.
### TABLE 3

**Summary of the numbers of formed elements found in the urine of cardiac patients**

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of patients</th>
<th>Formed elements</th>
<th>Lowest number</th>
<th>Highest number</th>
<th>Average number</th>
<th>Distribution of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients who had not suffered from cardiac failure</td>
<td>7</td>
<td>Casts</td>
<td>0</td>
<td>80,000</td>
<td>17,792</td>
<td>4* N† (2 = 0†, 2 H†); 3 &gt; ‡ N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red blood cells</td>
<td>22,250</td>
<td>428,000</td>
<td>162,531</td>
<td>7 N (2 A,† 5 H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White blood cells</td>
<td>96,000</td>
<td>1,788,000</td>
<td>809,555</td>
<td>7 N (2 A, 5 H)</td>
</tr>
<tr>
<td>Patients after recovery from heart failure</td>
<td>16</td>
<td>Casts</td>
<td>0</td>
<td>141,600</td>
<td>34,600</td>
<td>4 N (4 = 0); 12 &gt; N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red blood cells</td>
<td>165,000</td>
<td>3,090,000</td>
<td>917,515</td>
<td>4 N (4 H); 12 &gt; N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White blood cells</td>
<td>304,000</td>
<td>2,520,000</td>
<td>1,151,187</td>
<td>13 N (2 A, 11 H); 3 &gt; N</td>
</tr>
<tr>
<td>Patients during heart failure</td>
<td>18</td>
<td>Casts</td>
<td>0</td>
<td>463,740</td>
<td>66,485</td>
<td>6 N (4 = 0, 2 H); 12 &gt; N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red blood cells</td>
<td>72,210</td>
<td>3,090,000</td>
<td>834,754</td>
<td>9 N (1 A, 8 H); 9 &gt; N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White blood cells</td>
<td>70,000</td>
<td>17,877,000</td>
<td>3,089,302</td>
<td>13 N (1 A, 12 H); 5 &gt; N</td>
</tr>
</tbody>
</table>

* Refers to number of patients.
† N = normal, A = average, H = highest normal, 0 none.
‡ > N = greater than normal.
<table>
<thead>
<tr>
<th>Case number</th>
<th>Hospital number</th>
<th>Age and sex</th>
<th>State with reference to heart failure</th>
<th>Etiological</th>
<th>Anatomical</th>
<th>Physiological</th>
<th>Signs of heart failure</th>
<th>Medication effective in relief of heart failure</th>
<th>Urea clearance</th>
<th>Glomerular filtration rate per cent of normal</th>
<th>Sediment test (Addis)</th>
<th>Casts</th>
<th>Hyaline</th>
<th>Granular</th>
<th>Red blood cell number in 12 hours</th>
<th>White blood cell number in 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>7102</td>
<td>M.</td>
<td>During failure (+++++) Recovered</td>
<td>Arteriosclerosis, chronic myocarditis</td>
<td>Cardiac hypertrophy, chronic myocarditis, VPR</td>
<td>Auricular fibrillation, C.H.F.</td>
<td>++ + + + + + + 1</td>
<td>Digitalis</td>
<td>62</td>
<td>64</td>
<td>19,600</td>
<td>100</td>
<td>175,000</td>
<td>525,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>7234</td>
<td>M.</td>
<td>During failure (+++++) Recovered</td>
<td>Arteriosclerosis, chronic myocarditis, VPR</td>
<td>Cardiac hypertrophy, chronic myocarditis, VPR</td>
<td>Normal rhythm, C.H.F.</td>
<td>++ + + ++ + + 1</td>
<td>Digitalis</td>
<td>71</td>
<td>52</td>
<td>0</td>
<td>540,000</td>
<td>810,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>7309</td>
<td>M.</td>
<td>During failure (+++++) Recovered</td>
<td>Arteriosclerosis, chronic myocarditis, VPR</td>
<td>Cardiac hypertrophy, chronic myocarditis, VPR</td>
<td>Auricular fibrillation, C.H.F.</td>
<td>++ + + + + + 1</td>
<td>Digitalis</td>
<td>70</td>
<td>64</td>
<td>33,440</td>
<td>50</td>
<td>912,000</td>
<td>304,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>7337</td>
<td>M.</td>
<td>During failure (+) Recovered</td>
<td>Arteriosclerosis, hypertension</td>
<td>Cardiac hypertrophy, chronic myocarditis, VPR</td>
<td>Normal rhythm, C.H.F.</td>
<td>++ + + 0 0 + + 1</td>
<td>Without medication</td>
<td>90</td>
<td>44</td>
<td>0</td>
<td>1,505,000</td>
<td>645,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>7266</td>
<td>M.</td>
<td>During failure (++++) Recovered</td>
<td>Rheumatic fever</td>
<td>Cardiac hypertrophy, mitral stenosis, mitral insufficiency</td>
<td>Normal rhythm, C.H.F.</td>
<td>++ + + + + + + 1</td>
<td>Without medication</td>
<td>0</td>
<td>0</td>
<td>1,650,000</td>
<td>330,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Rt. I-V-IHB = right intraventricular heart block.
### Table 5
The urinary sediment of cardiac patients who have not suffered from heart failure of the congestive type

<table>
<thead>
<tr>
<th>Case number</th>
<th>Hospital number</th>
<th>Age and sex</th>
<th>State with reference to heart failure</th>
<th>Diagnosis</th>
<th>Physiological</th>
<th>Sediment test (Addis)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>per cent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>per cent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>per cent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>per cent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>per cent</td>
</tr>
<tr>
<td>24</td>
<td>7074</td>
<td>67 M.</td>
<td>Compensated</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy, mitral insufficiency, VPL</td>
<td>Normal rhythm, anginal syndrome</td>
</tr>
<tr>
<td>25</td>
<td>7067</td>
<td>71 M.</td>
<td>Compensated</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy</td>
<td>Normal rhythm</td>
</tr>
<tr>
<td>26</td>
<td>7180</td>
<td>65 M.</td>
<td>Compensated</td>
<td>Arteriosclerosis</td>
<td>Cardiac hypertrophy, chronic myocardiitis</td>
<td>Normal rhythm, anginal syndrome</td>
</tr>
<tr>
<td>27</td>
<td>H. H.*</td>
<td>54 M.</td>
<td>Compensated</td>
<td>Arteriosclerosis</td>
<td>Slight cardiac hypertrophy</td>
<td>Normal rhythm, anginal syndrome</td>
</tr>
<tr>
<td>28</td>
<td>E. H.*</td>
<td>45 M.</td>
<td>Compensated</td>
<td>Hypertension, 1 year later</td>
<td>Cardiac hypertrophy</td>
<td>Normal rhythm</td>
</tr>
<tr>
<td>29</td>
<td>6323</td>
<td>52 M.</td>
<td>Compensated</td>
<td>Hypertension</td>
<td>Cardiac hypertrophy</td>
<td>Normal rhythm</td>
</tr>
<tr>
<td>30</td>
<td>7128</td>
<td>45 M.</td>
<td>Compensated</td>
<td>Hypertension</td>
<td>Cardiac hypertrophy, VPL</td>
<td>Normal rhythm</td>
</tr>
</tbody>
</table>

* Out-patient.
In such patients the number of casts was therefore increased, the average being 20 times that in normal subjects; the increase was not so great, however, as in cases of heart failure of the congestive type. The red cell and white cell counts were, however, definitely less; the average numbers though twice as great as in normal individuals were, nevertheless, within normal limits.

**Urinary sediment and renal function.** Renal function was studied in certain patients by means of the urea clearance test (3) and the excretion of phenolsulphonphthalein, but no relationship was observed between the degree of renal impairment and the number of casts, and red and white blood cells passed in 12 hours (tables 1, 2, 4 and 5).

**DISCUSSION**

In cardiac patients who exhibited *no signs of heart failure* Stewart and McIntosh (4) found that renal function measured by the Van Slyke index of urea excretion (5) and phenolsulphonphthalein excretion was usually normal, without reference to whether they had previously suffered attacks of congestive heart failure. Although normal in these respects, diminution of function was detected, nevertheless, in these individuals by means of the concentration and dilution tests (4); their kidneys could not in many instances excrete urine of high or of low specific gravity. This impairment was most frequent after attacks of heart failure of the congestive type. It is of course well known that decrease in renal function as measured by the urea index and phenolsulphonphthalein excretion is frequently observed during heart failure of the congestive variety and that return toward normal takes place as the signs of failure disappear (6). This is commonly attributed to congestion of the kidneys. No studies have yet been published of the number of formed elements in the urine of such patients. Increase in albumin in the urine and presence of casts, red blood cells and white blood cells in heart failure are, as abnormality in the case of chemical tests, commonly attributed to congestion. The actual numbers we have now counted. The cases studied are too few for statistical treatment, but the degrees of heart failure encountered were sufficient, we think, to suggest the limits within which the numbers may be expected to fall.

The most consistent finding was increase in the number of casts, the
average being 20 to 60 times greater than normal, depending on the severity of the disease. The number was smallest when failure of the congestive type had not occurred, somewhat greater when it had, though at the moment no signs were present, and greater still when they were. Granular casts which Addis (2) did not find in the urines of normal individuals were found in approximately half the cases.

During heart failure and after recovery increased numbers of red and white blood cells occur but almost as frequently they are within the normal range. When heart failure has not taken place red and white blood cells are within normal range, although the averages are approximately twice those of normal individuals. But in patients who have experienced heart failure the numbers are 10 to 15 times greater than normal. In Addis's (2) opinion it is only the appearance of a

<table>
<thead>
<tr>
<th>Casts</th>
<th>No attacks of heart failure &lt; Recovered from failure &lt; During failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cells</td>
<td>No attacks of heart failure &lt; Recovered from failure = During failure</td>
</tr>
<tr>
<td>White blood cells</td>
<td>No attacks of heart failure &lt; Recovered from failure &lt; During failure</td>
</tr>
</tbody>
</table>

million or more red cells that can be regarded as significant. We could find no association, however, between the number of formed elements and the number of attacks of heart failure, nor between the degree of impairment of renal function (the urea clearance test and the phenolsulphonphthalein excretion) and the number of formed elements in the urine. Etiology, so far as we could see, played no rôle, though the series is small to adopt an opinion on this point. Renal failure casts (Addis (7)) were not observed. On the whole it is surprising that the number of casts, red blood cells and white blood cells in the urines of cardiac patients is so small and that it is so little increased during cardiac decompensation (table 6), that there is, in short, so little alteration in function.

We wish to emphasize a point already made by Addis (2), namely
that the numbers of casts, red blood cells and white blood cells have no individual significance. In these cases furthermore the numbers of formed elements counted were small; they serve only to define the order of magnitude and to establish the limits or range of variation. It is only when they are large, as in Bright's disease, that the absolute numbers are significant. It is of course for this reason that the comparison between the stages of absence and presence of heart failure in the same patient sometimes shows decrease and sometimes increase; in this sense alone greater numbers of casts and white blood cells are found in the presence of heart failure, though the number of red blood cells is approximately the same.

SUMMARY

1. The number of casts found in 12 hours is usually increased in patients suffering from cardiac disease, although the number may be normal. If the average numbers are considered, the greatest numbers were passed by those patients suffering from heart failure of the congestive type; the numbers were fewer after recovery and fewer still in those who had never suffered from this illness. Granular casts were frequently found.

2. The number of red blood cells in the urine of patients who had experienced cardiac decompensation was frequently greater than the highest normal value, but within the limits in those who had never suffered from heart failure. The average number of red blood cells found in those cases which had never experienced heart failure was twice as great as that in normal individuals; in those who were suffering from heart failure or had recovered from it, however, the average number was 10 to 15 times as great as in normal individuals.

3. The number of white blood cells was normal in the urine of those patients who had not suffered from heart failure, but the average number was approximately twice the average observed in normal individuals. The number was usually within the normal range both during and after recovery from cardiac decompensation; the average number, however, was greater approximately 9 and 3 times respectively than that in normal individuals, the average being less in patients without heart failure than in those who had recently recovered from it and less than in those who were still suffering.
BIBLIOGRAPHY


