ON
FOUR HUNDRED CASES OF AMPUTATION
PERFORMED AT ST. GEORGE'S HOSPITAL,
FROM OCTOBER, 1874, TO JUNE, 1888;
WITH ESPECIAL REFERENCE TO THE DIMINISHED
RATE OF MORTALITY.

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To vol. i of the 'St. George's Hospital Reports,' published in 1866, Mr. Holmes contributed a paper dealing with 300 cases of amputation. The statistics were obtained from the "Amputation Book," in which are recorded particulars of all amputations performed since the year 1852. Partial amputations of the hand and foot, which are usually performed by the house surgeons, are not included, but complete operations, such as Lisfranc's or Chopart's, find a place. Vol. viii of the same 'Reports,' published in 1878, contained a second paper also by Mr. Holmes on a further series of cases, 200 in number. In this second paper Mr. Holmes made some remarks on the antiseptic treatment of cases of amputation.

We propose now to consider a third series of 400 cases, dealing with the amputations performed between October, 1874, and June, 1888, following the lines that were laid down by Mr. Holmes in order to facilitate comparison of results. We have endeavoured to set forth the statistics in the plainest possible manner, and to let the figures, as far as may be, speak for themselves. The record is a continuous one. The three series, in fact, comprise a total of 900 consecutive amputations performed by twelve surgeons at one hospital during a period of thirty-six years. It follows, therefore, that to a limited extent only can the figures be taken to show the difference between the results obtained before and those subsequent to the general adoption of the antiseptic system. Our cases date from October, 1874. Previously to 1880 the records only occasionally note the employment of antiseptic treatment on the Listerian method. In 1876, for instance, silken ligatures were very commonly employed. Usually one end was cut off short, and the long ends, gathered together in a bundle, were brought out at the corner of the wound, providing in this way to some extent for drainage, though the importance of this principle was not perhaps so fully recognised as it is now. Layers of lint soaked in carbolic acid solution were usually laid over the wound and covered by oiled silk. At the conclusion of an amputation the wound was frequently syringed out with cold water or with iced carbolic solution. This latter detail was by no means the invariable practice, but it was certainly in 1876 one very frequently employed as far as amputations were concerned. Due attention was paid to cleanliness, but no attempt was made, by soaking in antiseptic fluids, to render the instruments or ligatures or the hands of the surgeon aseptic. Cases of other kinds were often treated on the Listerian method. The system had indeed been employed, as in other hospitals, for some years.¹ In 1877 catgut ligatures came into general use.

During the period 1877-9 the methods were constantly

¹ 'St. George's Hospital Reports,' vol. iii (1868), p. 241.

changing. Taking a few cases almost at random from our records for 1878 and 1879, we find, for example, the following notes on the methods and dressings employed :—"Antiseptic method throughout ; catgut ligatures ; drainage." The next :—"Carbolic dressings ; drainage-tube ; silk ligatures." In some cases dry dressings were used, and in a very few irrigation of the open wound was practised.

In 1880 minute attention was paid to all detail which might be considered to affect injuriously the asepticity of an amputation wound. At this period and for some years subsequently the carbolic spray was generally used for amputations. Of late years it has almost entirely been abandoned, with great advantage. It may be noted here, parenthetically, that since the adoption of catgut ligatures the occurrence of secondary hæmorrhage has been very rare. Two such cases are recorded under Table VI, D. In one of these gangrene had followed fracture of the surgical neck of the humerus in a man aged 71, and the arm was amputated. Secondary hæmorrhage took place on the sixth day, and the patient died on the seventh day. Post mortem the vessels were found to be atheromatous. The other occurred in a patient whose leg was amputated through the knee-joint for a malignant tumour of the leg.

Consecutive hæmorrhage happened once in a way when some vessel that did not bleed at the time of operation was overlooked, but the formidable hæmorrhage due to the ulceration of a large vessel seems to have been almost entirely done away with. Yet this used occasionally to occur with the silken ligatures. When the vessels are diseased and atheromatous, catgut or tendon seems beyond question the safest material at present available.

These 400 amputations, then, comprise a large proportion of cases treated strictly (according to the present state of our knowledge) on the antiseptic system, but also a considerable number in which other, or what would now be called imperfectly antiseptic methods were employed. It is often supposed that the practice of a general hospital

is greatly bound by traditions. To imagine this to be the case is to presuppose a very limited capacity for improvement. The methods in vogue are in reality in a constant state of modification with the view of further improvement. That which might be accepted as nearly perfect to-day may be, almost surely will be, considered worse than antiquated a few years hence. The practice as regards amputations at St. George's Hospital is the same as obtains in all general hospitals. The patient is considered before the amputation book. The possibility—however remote—of saving life or relieving suffering, even if only for a short time, is held paramount. The statistician may employ the figures and tabulate the results, but he has absolutely no influence on the practice.

It is worthy of remark that more amputations were performed during the second than during the first half of the period covered by these statistics. For the six years 1876 to 1881 (inclusive) 146 cases are tabulated, and for the six years from 1882 to 1887 (inclusive), 203. Taking into account the increasing reluctance of surgeons to submit their patients to amputation it is at least probable that these 203 included an even larger number of unpromising cases than the 146. On the whole, however, it is better to assume that the class of cases did not greatly differ from those previously tabulated, though if any advantage could be shown to exist it would probably be found in the earlier series. The hospital was re-floored in 1886-7, hard wood (teak) being substituted for the deal that had stood the wear and tear and scrubbing of many years, but otherwise no substantial alteration was made in the building, and the same number of beds was available. The conditions then under which the present series of amputations was performed were much the same as in former years. Save for the introduction and elaboration of the antiseptic method no potent factor can be held accountable for any alteration in the rate of mortality. That rate, Mr. Holmes concluded,¹

¹ Vol. i, p. 320.

varies, *cæteris paribus*, with the prevalence of pyæmia. Our investigation clearly proves the truth of this remark, as will be seen later on.

The two main points to which Mr. Holmes directed attention in his first paper were¹—

1. The influence of advancing age on the results of amputation.

2. The proportion of cases dying from the effects of previous injury and disease to those dying from the sequelæ of the operation.

With regard to the first of these subjects of inquiry we need say little. The following tables furnish at a glance an interesting comparison.

TABLE I.

	First series. Feb., 1852, to Feb., 1866.		Second series. June, 1862, to Oct., 1874.		Third series. Oct., 1874, to Oct., 1888.		Total.		Deaths per cent.				
	No.	Died.	No.	Died.	No.	Died.			No.	Died.	1st ser.	2nd ser.	3rd ser.
Under 5 years . . .	1	0	4	1	16	2	21	3	—	25·0	12·5	14·3	
Above 5 and under 10	14	1	6	1	30	1	50	3	7·1	16·6	3·3	6·0	
„ 10 „	15	21	16	3	28	4	65	8	4·7	18·7	14·2	12·3	
„ 15 „	20	47	21	7	44	8	112	23	17·0	33·3	18·1	20·5	
„ 20 „	30	74	46	16	95	14	215	44	18·9	34·7	14·7	20·4	
„ 30 „	40	53	42	17	63	9	158	47	39·6	40·4	14·2	29·7	
„ 40 „	50	41	34	14	58	12	133	41	36·5	41·1	20·7	30·8	
„ 50 „	60	34	17	9	40	18	91	44	50·0	52·9	45·0	48·3	
„ 60 „	70	13	10	6	20	11	43	22	38·4	60·0	55·0	51·1	
„ 70 . . .	2	1	4	1	4	3	10	5	50·0	25·0	75·0	5·0	
Adults of unknown age	—	—	—	—	2	2	2	2	—	—	—	100·0	
	300	83	200	75	400	84	900	242	27·6	37·5	21·0	26·8	

The most noticeable contrast will be observed in the third series of amputations, between the ages of twenty and fifty. The mortality between the ages of twenty and thirty, which in the first series amounted to 18·9 per cent., and in the second series to 34·7 per cent., in the third has fallen to 14·7 per cent. Between the ages of thirty and forty the

¹ Ibid., p. 292.

figures are still more striking, for the mortality as shown in Table I, which in the first series was 39·6 per cent., and in the second 40·4 per cent., has in the third series fallen to 14·2 per cent. Between the ages of forty and fifty much the same results will be observed. The improvement shown in the third series is chiefly due to the diminished mortality in these three divisions.

Of the gross total (900) of amputations tabulated, 506 were performed on persons between twenty and fifty years of age. The third series illustrates in a very emphatic manner the influence of age, for with a greatly diminished gross rate of mortality this influence is as convincingly demonstrated as in the former tables.

The youngest case tabulated was that of a child aged $1\frac{1}{2}$, whose thigh was amputated for gangrene following a simple fracture of the femur. This patient died of pyæmia (Table VI, A, No. 5). The condition may have been due to fat embolism, but there was a wound also of the other foot. The oldest was a woman aged 77, whose forearm was amputated for epithelioma attacking a burn of the hand of sixty-eight years' standing. This patient made an uninterrupted and quick recovery.

The following table (II) shows the ages of the patients in our series of cases :

TABLE II.

	No. of cases.	Deaths.	Per cent.
Under 5 years	16	2	12·5
Above 5 and under 10	30	1	3·3
„ 10 „ 15	28	4	14·2
„ 15 „ 20	44	8	18·1
„ 20 „ 30	95	14	14·7
„ 30 „ 40	63	9	14·2
„ 40 „ 50	58	12	20·7
„ 50 „ 60	40	18	45·0
„ 60 „ 70	20	11	55·0
„ 70	4	3	75·0
Adults of unknown age	2	2	100·0
	400	84	21·0

Assuming, for convenience' sake, that of the two adults mentioned in the last line one was under and one over thirty, we have, out of 463 amputations under the age of thirty, 81 deaths; and out of 437 amputations over the age of thirty, 161 deaths, or almost exactly double. This is precisely the result at which Mr. Holmes arrived.¹ The diminished rate of mortality is a general diminution. We shall endeavour to show subsequently that it is chiefly due to the rare occurrence in recent years of pyæmia after amputations, and shall ascribe this to the more perfect employment of the antiseptic system. Nevertheless the influence of age remains the same, and this fact should be noted in questions of prognosis. Three hundred and thirty-nine of the cases in the third series were under fifty years of age, and of these 50 died. Sixty-one were over fifty, and of these 34 died. The contrast is astonishing. Yet these older people had every advantage and security which the most modern and improved methods could give. For all that they died. Whatever the methods employed amputation is about four times as dangerous after the age of fifty as it is before. No doubt the disorders for which amputation is necessary in later life are, on the whole, much graver than in those less than fifty years of age. Chronic diseases of the joints, if the operation be not too long deferred, are eminently favorable for amputation. Such cases are rarely met with in old people, while they constitute the great bulk of the "Pathological" amputations in the young. Gangrene, again, and the like grave disorders swell the mortality in the old. Loss of blood is less well withstood, and the general recuperative power is feebler. A much larger percentage in the old really die from the effects of previous disease than from the operation or its sequelæ. This point will, however, be dealt with later on. It suffices now to note that the concentration of attention on the condition of the amputation wound is not in itself likely to lead to a diminution of mortality in the old after amputation. The older

¹ 'St. George's Hospital Reports,' vol. viii, p. 283.

the patient, the more must he be considered apart from his wound.

The second point to which we desire to draw attention is the proportion of cases dying from the effects of previous injury and disease to those dying from the sequelæ of the operation.

It is, of course, obvious that no improved system of wound treatment is likely to affect this proportion to any very great extent. Indeed, if any influence at all could be expressed, it is possible that it might not be in the direction of improvement as regards the mere figures. A method which aims at and almost invariably succeeds in obviating traumatic fever may lead the surgeon to amputate in extremely unfavorable cases, as, for example, in advanced phthisis. On this second point there is no satisfactory way of illustrating by figures any contrast between our series and those previously tabulated. Yet it can hardly be doubted that some such improvement exists and affects the general diminution of mortality. Improved after-treatment, greater efficiency and skill in nursing, increased watchfulness of detail, must have much to do with the better results, for after all the antiseptic system is directed to the operation wound primarily, and not so much to the patient who has been operated on. The antiseptic system is a most powerful weapon of defence, but it is not a whole armament, and if the figures work out to much the same totals the explanation is probably to be found in the greater severity of the cases operated on. Some support is lent to such an inference by the increased number of amputations shown by our tables to have been performed during the last few years. An appreciable number of these cases would possibly have been considered too hopeless for operation in former years. For instance, the presence of albumen in the urine was at one time held almost sufficient of itself to contra-indicate operation, even amputation. Yet there are many cases in our series, especially those of patients suffering from inveterate bone disease or joint affections of long standing,

who at the time of operation had marked albuminuria, which after operation either entirely disappeared or gradually diminished to a mere trace. Slowly progressing sclerosis of bone attended by much pain is particularly associated with this albuminuria, and the presence of the symptom frequently indicates the necessity for rather than vetoes the amputation.

The results of the various amputations performed may now be analysed to some extent. Attention may again be drawn to the rule which has guided us throughout in estimating the mortality. If a patient who has been the subject of an amputation dies while still on the books of St. George's Hospital the case is reckoned as one of death after amputation, whatever the proximate cause may have been. Clearly, as will be seen by the remarks made below, many cases tabulated as deaths after amputation ought strictly never to have been so entered. Yet it seemed better not to depart in any degree from the plan hitherto adopted, nor to seek to arrange the results so as to give the most favorable impression. A certain number of patients who are entered as "recovered" may have died shortly after leaving the hospital, and thus form a set-off. As an example, a patient with, say, a diseased knee and pulmonary tuberculosis undergoes amputation of the thigh. The stump heals, and the patient dies of phthisis some weeks or months later than would have been the case if he had been dragged down by the pain of the diseased joint. Yet such a case would be, and is in our tables reckoned as, a death after amputation. Again, a similar patient has his arm removed for diseased elbow. The flaps break down, the bone protrudes, the pulmonary trouble if anything is made worse. The patient leaves the hospital wishing "to die at home," and probably does so shortly. The case is entered as a "recovery." Truth to tell, the mortality of a given hospital forms but the coarsest guide to the success of its practice, but no other test can well be applied.

In order to furnish, as far as possible, material for

comparison, the different varieties of amputations comprised in our 400 cases have been set forth in the following tables :

Amputation at Hip-joint for Disease.

	No. of cases.	Died.	
From 5 to 10	2	1	Hip disease. Death from shock in 2 hours.
From 10 to 15	2	1	Periostitis of femur and disorganisation of hip-joint. Died from exhaustion and vomiting in 21 days.
From 15 to 20	1	1	Similar case to above. Death from shock in 20 minutes.
From 20 to 30	3	2	1. Broncho-pneumonia ; lardaceous liver, kidneys, and spleen. 2. Exhaustion ; patient in a very weak state at time of operation, to which he had refused consent.
From 30 to 40	1	—	—
From 40 to 50	1	1	Old hip disease. Death from exhaustion in 12 hours.
	10	6	

Mortality 60 per cent.

The number of cases is too small to justify us in drawing any conclusions. From the nature of the cases the large mortality is not surprising, for the operation was in all undertaken more with the object of prolonging or making life more endurable than of actually saving it.

*Primary and Secondary Amputations of the Thigh,
including Double Amputation.*

	No. of cases.	Died.	
Under 2 years	1	1	From pyæmia (Table VI, A, No. 5).
From 5 to 10 years	1	1	From shock.
From 10 to 15 years	3	2	1 from shock and other injuries.
From 15 to 20 years	1	0	—
From 20 to 30 years	3	1	From shock and hæmorrhage from accident.
From 30 to 40 years	8	4	1 from exhaustion, the other leg having been amputated at knee; 1 collapse, loss of blood at time of accident; 1 exhaustion (case of suicide); 1 collapse on operating table.
From 40 to 50 years	8	5	1 on table (both thighs); 1 from shock, hæmorrhage before operation; 1 from pyæ- mia (?) before operation (Table VI, A, No. 6); 1 from diabetes; 1 from pyæmia following simple fracture into the knee-joint (hæmar- throsis and suppuration) (pyæmia probably preceded operation) (Table VI, A, No. 7).
From 50 to 60 years	8	6	1 from exhaustion; 1 from hæmorrhage at time of accident; 1 visceral disease; 3 from shock, of which 1 died on table.
From 60 to 70 years	1	1	1 from shock.
One man, age unknown, died from shock in a few hours.			
	1	1	
	35	22	

Mortality 62 per cent.

Amputation of Thigh for Disease.

	No. of cases.	Died.	
Under 5 years	6	0	—
From 5 to 10 years	17	0	—
From 10 to 15 years	11	1	From tuberculosis.
From 15 to 20 years	17	6	From phthisis and exhaustion 1; from pyæmia before operation 2; from exhaustion and prolonged suppuration before operation 2; from shock and hæmorrhage in previous sequestrotomy 1.
From 20 to 30 years	32	4	From shock 1; hæmorrhage 2; from pyæmia 1 (Table VI, A, No. 3); from phthisis 1.
From 30 to 40 years	21	1	From exhaustion and erysipelas before operation.
From 40 to 50 years	20	4	From erysipelas 1; from exhaustion 2; from diabetes 1.
From 50 to 60 years	6	3	From exhaustion in case of senile gangrene 1; from tetanus 1; from exhaustion and chronic suppuration 1.
From 60 to 70 years	5	3	From recurrent hæmorrhage and exhaustion 1; from exhaustion and gangrene 1; from exhaustion due to gangrenous cellulitis 1.
Above 70 years	1	1	From gangrene of flaps.
	136	23	

Mortality 16·9 per cent.

These tables call for no special comment, save that they illustrate well the influence of age, which has already been considered.

Amputation through Knee-joint for Disease.

	No. of cases.	Died.
Above 15 years of age and under 20 . . .	1	0
„ 20 and under 30 . . .	7	1
„ 30 „ 40 . . .	5	0
„ 40 „ 50 . . .	4	0
„ 60 „ 70 . . .	3	3
	20	4

Mortality 20 per cent.

Primary and Secondary Amputations through the Knee-joint, including Multiple Amputations.

Six cases. Four deaths.

In three of these fatal cases the amputation was double.

Amputation through Knee-joint.

Deaths.

1. Lisfranc on other foot at same time ; primary amputation ; traumatic delirium day after operation. Died of exhaustion after 10 days.
2. Malignant tumour of leg ; secondary hæmorrhage.
3. Primary ; right thigh amputated above condyles ; left through knee. Died of exhaustion after 14 days.
4. Double amputation ; primary ; right through knee ; left leg about middle. Died of exhaustion after 23 days.
5. For old ulcer of leg ; recurrent hæmorrhage from stump ; sloughing of flap. Died of exhaustion after 40 days.
6. Primary ; case of compound fracture ; much collapse on admission. Died after 3 days.
7. For senile gangrene, to relieve intense pain ; commencing gangrene of flaps. Died of asthenia after 6 days. Pain ceased after operation.
8. Man, æt. 61. Chronic abscess of head of tibia ; flaps retracted. Died of pyæmia (Table VI, A, No. 8).

Most of these amputations were performed in the manner advocated by Mr. Stephen Smith. The healing was often slow but the resulting stumps left nothing to be desired.

Amputation of Leg for Disease.

	No. of cases.	Died.	
Under 5 years of age	1	—	—
Above 5 and under 10	6	—	—
„ 10 „ 15	7	—	—
„ 15 „ 20	8	—	—
„ 20 „ 30	8	1	From septicæmia, which existed previous to amputation.
„ 30 „ 40	8	—	—
„ 40 „ 50	9	1	From pyæmia (Table VI, A, No. 1).
„ 50 „ 60	9	2	1 from sloughing and gangrene; 1 from erysipelas.
„ 60 „ 70	2	2	1 from gangrene; 1 from exhaustion.
	58	6	

Mortality 10·3 per cent.

Primary Amputation of Leg, including Double and Multiple Amputations.

Age.	No. of cases.	Deaths.	
Under 5 years	1	0	—
Above 10 and under 20	2	0	—
„ 20 „ 30	6	1	From shock; both forearms also amputated.
„ 30 „ 40	3	1	Exhaustion and gangrene after compound fracture.
„ 40 „ 50	4	0	—
„ 50 „ 60	5	4	2 from shock; 1 from other injuries, and 1 from pyæmia which existed previous to amputation.
„ 60 „ 70	2	2	1 from delirium and exhaustion, and 1 from other injuries.
„ 70.....	1	1	Secondary after compound fracture; sloughing and exhaustion.
Age unknown.....	1	1	Shock.
	25	10	

Mortality 40 per cent.

Syme's Amputation.

Age.	Cases.	Recovered.	Died.
Under 5 years . . .	4	4	
Above 5 and under 10 . . .	4	3	1
„ 10 „ 85 . . .	3	3	
„ 15 „ 20 . . .	6	5	1
„ 20 „ 30 . . .	14	12	2
„ 30 „ 40 . . .	3	3	0
„ 40 „ 50 . . .	4	3	1
„ 50 „ 60 . . .	3	3	
„ 60 „ 70 . . .	3	3	
	44	39	5

Mortality 11·3 per cent.

1. Pyæmia. Died after 20 days. Suppuration of ankle (Table VI, A, No. 2).
2. Carbolic acid poisoning; sloughing of heel flap. No post-mortem examination (Table VI, A, No. 4).
3. Died after 71 days; stump not healed; hæmorrhage from rectum and dysenteric diarrhœa. No post-mortem.
4. Died of phthisis, bedsores, and exhaustion; sloughing of heel flap. No post-mortem.
5. Flap sloughed; urine became albuminous; diarrhœa, ascites, and vomiting. Died in 50 days of lardaceous disease.

*Amputation through Shoulder-joint.**Primary for Accident.*

Æt.	No.	Died.
20	1	0

For Disease.

Age.	No. of cases.	Died.	
From 15 to 20 years	1	—	—
„ 20 to 30 „	3	1	Death from shock in 7 hours.
„ 30 to 40 „	3	—	—
„ 40 to 50 „	1	—	—
„ 50 to 60 „	1	1	Death from exhaustion in 5 days.
	9	2	

Mortality 22 per cent.

Amputation of Arm for Accident.

Age.	No. of cases.	Died.	
Under 5 years	1	0	—
From 5 to 10 years	1	0	—
„ 10 to 15 „	—	—	—
„ 15 to 20 „	—	—	—
„ 20 to 30 „	4	0	—
„ 30 to 40 „	3	1	From penetrating wound of chest.
„ 40 to 50 „	3	0	—
„ 50 to 60 „	1	0	—
„ 60 to 70 „	1	1	From shock.
Above 70	1	1	Gangrene and exhaustion.
	15	3	

Mortality 20 per cent.

Amputation of Arm for Disease.

Age.	Cases.	
Above 15 and under 20	4	} All recovered.
„ 20 „ 30	3	
„ 30 „ 40	1	
„ 50 „ 60	2	
	10	

Amputation of Forearm for Disease.

Age.	Cases.	Died.
Between 20 and 30	8	1
„ 30 and 40	7	0
„ 40 and 50	4	0
„ 50 and 60	5	1
„ 60 and 70	3	0
„ 70 and 80	1	0
	28	2

Primary Amputation of Forearm.

Age.	Cases.	Died.
Between 10 and 20	3	0
„ 20 and 30	4	2
„ 30 and 40	1	0
	8	2

1. Both forearms and leg ; primary. Died in 10 hours.
2. Deformity from old burn seemed doing well when severe vomiting came on on 117th day and could not be stopped. No post-mortem. ? Died of operation.
3. Stump healed. Died in 49 days. Post-mortem, advanced phthisis.
4. Many other injuries ; fracture right femur and left clavicle, scalp wound, and wound of right foot, from which pyæmia developed, of which he died in 7 days. Primary amputation.

We have thought it as well to tabulate these cases, though practically amputation of the forearm *per se* is an operation of infinitesimal risk. In the 'Pathological' series, as will be seen, two deaths occurred. These can only be included in our tables by the necessity for rigid observance of the rule laid down at the commencement of this paper. In one case the patient, who was fifty-five years of age, died from circumstances wholly unconnected either with the operation or the disease that had rendered it necessary. In the other the object of the operation was fully attained, and the patient was relieved of a painful local disease, but died of advanced phthisis.

We may now briefly consider the deaths after operation, and their causes.

Table III furnishes the results of—

(A) Amputation for disease.

(B) Amputation for injury, chiefly primary.

(c) Double or multiple amputations for injury.

In the first section (A) we have 314 cases and 48 deaths, showing a mortality of 15·2 per cent. In the second section (B) 79 cases with 29 deaths, a mortality of 36·6 per cent. In the third section (c) 7 cases and 7 deaths, a mortality of 100 per cent. In some of the cases tabulated under (c) the injuries were not limited to the limbs amputated, and the operations were undertaken with little more hope than that of enabling the sufferers to pass more peacefully out of the world.

TABLE III.

(A) *Amputation for Disease.*

Nature of amputation.	No. of cases.	Deaths.
Thigh	136	23
Thigh at hip-joint	10	6
Leg	58	6
Leg at knee-joint	19	4
Syme	44	5
Arm	10	—
Arm at shoulder-joint	9	2
Forearm	28	2
	<hr/> 314	<hr/> 48

I. e. 15·2 per cent.(B) *Primary Amputations.*

Nature of amputation.	No. of cases.	Deaths.
Thigh	32	18
Leg	21	6
Leg at knee	3	1
Arm	15	3
Forearm	8	1
	<hr/> 79	<hr/> 29

I. e. 36·6 per cent.(C) *Primary Double and Multiple Amputations.*

Nature of amputation.	No. of cases.	Deaths.
Thighs, both	2	2
Thigh and other leg at knee-joint	1	1
Leg „ „	1	1
Legs, both	1	1
Legs at knee-joint and Lisfrane	1	1
Leg and both forearms	1	1
	<hr/> 7	<hr/> 7

I. e. 100 per cent.*Summary.*

For disease	314 cases, of which 48 died.
Primary	79 „ „ 29 „
„ double or multiple	7 „ „ 7 „
	<hr/> 400
	<hr/> 84

TABLE IV.

From causes unconnected with the operation ; death inevitable.

No.	Nature of amputation.	Amp. book No.	Age.	Remarks.
1	Leg, secondary	508	37	Limb removed for gangrene following compound fracture. Death in 3 days.
2	Legs, primary	509	50	Railway accident; both legs amputated; never rallied from shock of injury. Death on 3rd day.
3	Thighs, primary	510	13	Both thighs amputated; also compound fracture of arm. Death in a few hours.
4	Leg at knee, primary	513	68	Railway accident; delirium came on one hour after injury; Lisfranc's amputation on other foot. Death in 10 days.
5	Leg, primary	517	28	Railway accident; extreme collapse; both forearms also removed. Death in 10 hours.
6	Thighs, primary	523	44	Both thighs removed. Death on operating table.
7	Leg, secondary	527	57	For suppuration and necrosis in case of compound fracture into ankle-joint 5 weeks previously; pyæmia existing prior to amputation. Death in 7 days.
8	Leg, primary	528	56	Died in 2 days without recovering from original shock.
9	Arm, primary	562	31	Gunshot wound, causing great collapse. Death in 2 days.
10	Thigh, primary	564	38	Other leg removed through knee-joint; railway accident. Death in 14 days.
11	Do.	577	?	Other injuries. Death in 5 hours.
12	Forearm	583	55	Removed for extensive ulceration from burns. Died vomiting on 117th day. No post-mortem. (This case ought probably to be classed as a recovery from amputation.)
13	Thigh, primary	612	13	Also compound fracture of arm. Death in 8 hours.
14	Do.	613	32	Severe loss of blood prior to operation. Death in 48 hours.
15	Do.	619	33	Suicidal injuries. Death in 2 days.
16	Do.	633	35	Railway accident. Death on operating table.
17	Forearm, primary	650	23	Many other injuries, from which pyæmia was developed. P.M.—Multiple pyæmic abscesses. Death in 7 days.
18	Leg, primary	665	?	Both legs crushed. Death in 20 minutes.
19	Thigh, primary	666	3	Collapse from accident. Death in 3 hours.
20	Leg at knee, primary	671	62	Collapse from accident. Death in 3 days.

No.	Nature of amputation.	Amp. book No.	Age.	Remarks.
21	Thigh, primary	715	51	Loss of blood prior to amputation. Death in 36 hours.
22	Leg, caries of tarsus	717	31	Died exhausted in 3 days. P.M.—Tubercles in lungs.
23	Thigh, primary	758	55	Other injuries. Death on operating table.
24	Leg, primary	776	53	Other injuries. Death in 2 hours.
25	Thigh, for disease	841	61	Extensive gangrenous cellulitis of leg. Death in 6 hours.
26	Do.	855	50	Extreme exhaustion following suppuration of knee. Death in 8 hours.
27	Thigh, primary	870	58	Railway accident. Death in 8 hours.
28	Do.	876	44	Other injuries. Diabetes. Died comatose in 6 days.
29	Leg, primary	882	68	Fracture of base of skull; also compound fracture of other leg. Death in 2 days.
30	At hip-joint, for disease	886	17	Extreme exhaustion in case of periostitis and necrosis of femur. Patient almost moribund from prolonged suppuration. Hæmorrhage at operation from œdematous tissues. Death in 20 minutes.

TABLE V.

From other causes coinciding with the operation, the other causes having a main share in producing death.

CLASS A.—*Death due mainly to previous visceral or local disease.*

1	Leg, for senile gangrene	507	70	Gangrene attacked the flaps, and death occurred on 5th day. P.M.—Atheromatous vessels.
2	Thigh, for diseased knee	533	16	Tubercular child; very feeble from prolonged suppuration. Death on 4th day.
3	Do.	534	13	Suppuration of knee. Death in 11 days. P.M.—Tubercles in lungs.
4	Thigh, for failure of excision of knee	545	15	Died in 26 days, worn out by pain and suppuration following the excision.
5	At hip-joint	568	25	Operation previously declined; exhausted at time of amputation. Sank in 6 days.
6	Thigh, for pulpy disease of knee	574	22	Died of phthisis in 82 days.
7	Do.	575	46	Diabetes. Died in 12 days.
8	Forearm, for diseased wrist	604	28	Died in 49 days. P.M.—Advanced phthisis.

No.	Nature of amputation.	Amp. book No.	Age.	Remarks.
9	Syme, for disease of ankle	644	34	Wound not quite healed when man died on 71st day from hæmorrhage from rectum and dysenteric diarrhœa. No P.M.
10	Syme, for disease of tarsus	648	19	Phthisis. Heel flap sloughed. Death in 9 days from exhaustion and bed-sores. No P.M.
11	Thigh, for sarcoma of tibia	651	36	Myeloid sarcoma of tibia gouged out, followed by erysipelas and suppuration of the knee-joint. Death on operating table.
12	Thigh, for suppuration of knee	693	16	Phthisical patient. Acute periostitis of tibia, followed by destruction of knee-joint. Death in a few days. No P.M.
13	Do.	699	18	Suppurative arthritis of knee. Pyæmia before amputation. Death in 10 days.
14	Leg, for sloughing	702	54	Excision of os calcis was followed by sloughing of soft tissues of opposite heel. Diseased arteries. Death in 21 days.
15	At hip-joint	726	13	Periostitis of femur and suppuration of joint. Death in 21 days from exhaustion. P.M.—No morbid change found in internal organs.
16	Thigh, for diseased knee	732	15	Pyæmia and disorganisation of knee followed aspiration of joint for synovitis. Death in 41 days. P.M.—General tuberculosis.
17	Leg and knee, for gangrene	773	66	Operation to relieve pain in case of senile gangrene. Death on 6th day. P.M.—Embolism of mid-cerebral artery; atheroma.
18	Thigh, for gangrene	799	67	Death in 10 days. P.M.—Arterial degeneration and chronic interstitial nephritis.
19	At hip-joint	802	48	Prolonged suppuration of hip; bed-sores. Death in 12 hours.
20	Syme, for disease of tarsus	829	9	Death in 50 days from lardaceous degeneration of viscera.
21	At hip-joint, for disease of joint	830	23	Death in 27 days from broncho-pneumonia and lardaceous disease.
22	Leg, for senile gangrene	857	64	Amputated for severe pain. Gangrene attacked the flaps, and extended to the groin. Death in 11 days.
23	Thigh, for senile gangrene	899	54	Senile gangrene; thrombus in femoral artery at site of amputation. Death in 7 days. P.M.—Thrombosis of left pulmonary artery and external iliac artery.

CLASS B.—*Death due mainly to the consequences of previous injury.*

No.	Nature of amputation.	Amp. book No.	Age.	Remarks.
1	Leg, secondary	611	28	Railway accident. Right leg removed through the knee, and the left below the knee; sloughing of flaps and exhaustion. Death in 21 days. No P.M.
2	Thigh, secondary	632	55	For gangrene following primary excision of ankle-joint for compound dislocation. Drayman, in a low state. Death in 24 hours.
3	Thigh, for ruptured popliteal artery	641	58	Severe hæmorrhage at operation; great extravasation into soft tissues of limb. Death in 3 days.
4	Thigh, secondary	667	57	For sloughing after compound fracture. Died suddenly on 3rd day. P.M.—Fatty degeneration of cardiac muscles and granular kidneys.
5	Do.	688	41	After compound fracture; a piece of necrosed bone ulcerated into the popliteal artery; severe hæmorrhage and collapse. Death in 2 hours.
6	Leg, secondary	757	70	Compound fracture; flaps sloughed. Phlebitis and delirium. Death in 9 days. No P.M.
7	Thigh, secondary	787	50	Secondary to compound fracture; septicæmia. Death in 25 days. P.M.—No pyæmic deposits.
8	Thigh, primary	823	28	Severe hæmorrhage before admission. Death in 10 hours. (Possibly ought to be in Table I.)
9	Thigh, ruptured posterior tibial artery	854	66	Enormous extravasation of blood into leg. Death in 30 hours.
10	Arm, secondary	874	68	Commencing gangrene after compound fracture opening the elbow-joint. Death in 5 days.

TABLE VI.

Deaths from amputation, i. e. due mainly to the consequences of the operation itself.

CLASS A.—*From Pyæmia.*

No.	Nature of amputation.	Amp. book No.	Age.	Remarks.
1	Leg	526	44	R. A. had caused dislocation of the ankle and rendered the limb useless. Rigors on 5th day after amputation, and death from pyæmia followed on the 22nd day.
2	Syme, for disease of foot	536	41	Death from pyæmia in 20 days. Pyæmia began on the 17th day.
3	Thigh, for disease of knee	550	23	Death from pyæmia in 9 days. No P.M. examination.
4	Syme, for disease of tarsus	635	25	A delicate man with cardiac disease. Carboluria followed amputation. Septicæmia and sloughing of heel flap. Death in 10 days.
5	Thigh, secondary	716	1½	For gangrene following a simple fracture of thigh. Death from pyæmia in 17 days. There was also a wound of the other foot. (Pyæmia probably preceded the amputation.)
6	Do.	723	43	For compound fracture. Death from pyæmia in 12 days. (Pyæmia almost certainly preceded operation.)
7	Do.	833	49	Secondary for suppuration of knee following hæmarthrosis in case of fracture of femur into joint. Septicæmia. Death in 9 days. (Pyæmia probably preceded operation.)
8	Leg at knee, for disease of tibia	834	61	For chronic osteo-myelitis of tibia. Rigors and pyæmia, and death in 10 days. P.M.—Abscess in spleen and thrombosis of femoral vein.

CLASS B.—*Sloughing (in Mr. Holmes's papers this class included also Phagedæna).*

1	Thigh, for ulcer of leg	652	68	Recurrent hæmorrhage; sloughing of flaps; bedsores; exhaustion. Death in 40 days.
2	Thigh, for diseased knee	751	50	Sloughing and gangrene of flaps; osteo-myelitis; tetanus. Death in 19 days.

CLASS C.—*From Erysipelas.*

No.	Nature of amputation.	Amp. book No.	Age.	Remarks.
1	Thigh, for anky- losed knee	504	46	Died in 62 days from erysipelas, ex- haustion, and bedsores.
2	Leg	682	55	Amputated for old injury to foot. Ery- sipelas attacked the wound within 24 hours of the operation. Sloughing of flaps and bedsores. Death in 12 days.

CLASS D.—*From Secondary Hæmorrhage.*

1	Arm, secondary	516	71	For gangrene following fracture of sur- gical neck of humerus. Secondary hæmorrhage on 6th day. Vessels very atheromatous. Death on 7th day.
2	Leg and knee for malignant tumour of leg	555	22	Profuse secondary hæmorrhage. Death in 17 days.

CLASS E.—*Shock at Operation ; hæmorrhage.*

1	Thigh	521	27	Thigh removed for myeloid sarcoma at lower end of femur. Death in 18 hours from shock.
2	Do.	640	43	Ununited fracture of femur. Death from shock of operation on 3rd day. P.M. — Vessels atheromatous; heart fatty; emphysema of lungs; fibroid and fatty changes in liver.
3	Arm at shoulder	741	25	For sarcoma of humerus. Profuse hæmor- rhage and shock. Death in 7 hours.
4	Thigh	760	40	Amputated for secondary hæmorrhage after ligature of femoral artery for wound. Shock. Death in 2 days.
5	Arm at shoulder	761	58	For sarcoma of humerus. Severe hæ- morrhage at operation. Death in 5 days.
6	Thigh	821	17	For periostitis and necrosis of tibia. An attempt was made to remove the shaft of the tibia; this was followed by pro- fuse hæmorrhage, and the limb was at once removed. Shock. Death in 3 days.
7	Do.	826	29	Sarcoma of muscles of lower third of thigh. Profuse hæmorrhage; large muscular thigh. Shock. Death in 40 hours.

Still following Mr. Holmes' method of arranging the cases, we have drawn up a complete list of all the deaths. These Tables IV, V, and VI speak for themselves. The interest chiefly centres in the last two. It will be understood that our main object has been to afford a ready comparison with the previously published statistics drawn from the same source. Exception may be taken to the headings under which particular cases have been entered, but it has been our aim to secure uniformity even though some sacrifice should be involved in other respects. No branch of medical literature has been more fiercely criticised than the statistical. Undoubtedly the material is somewhat plastic, but much of the distrust excited by any statistical paper is due to two causes: one, the want of uniformity in statistics furnished from different quarters; the other, that advertisement so often unfortunately adopts the statistical guise. At the least we will endeavour to avoid the former of these two drawbacks. It is often said that "anything may be proved by statistics," and the statement is intended to imply distrust. It may be so; it is also difficult to prove anything in any other way.

Table IV comprises the deaths occurring from causes unconnected with the operation, and in which death was really inevitable. Thirty cases are included, twenty-six of these being primary or secondary amputations for injury. One of the deaths occurred in a patient whose forearm was amputated for extensive ulceration the result of a burn. This patient was attacked with severe vomiting and died on the 117th day after operation; no post-mortem examination was allowed. As regards the operation she had really recovered, but for reasons assigned already the case is entered here as a death after amputation.

Table V includes the deaths occurring from other causes coinciding with the operation, the other causes having a main share in producing death. These cases are divided into two classes.

CLASS A. *Death due mainly to previous visceral or local*

disease.—In this class we have twenty-three cases. In seven of these death was due mainly to phthisis. Four were cases of senile gangrene. Two died of pyæmia which existed markedly before operation. One man aged thirty-four, on whom a Syme's amputation had been performed, died on the seventy-first day from hæmorrhage from the rectum and dysenteric diarrhœa. No post-mortem examination was allowed. The wound had not quite healed.

CLASS B. *Cases due mainly to the consequences of previous injury*.—Ten cases, all primary or secondary. In one case septicæmia developed after compound fracture, and the limb was amputated. Death in twenty-five days. Post mortem no evidence of pyæmia was found. Some of these cases might perhaps more properly be transferred to Table IV.

Table VI includes the cases in which death may really be ascribed to the effects of the operation, or, if the term be preferred, from surgical calamities. Altogether twenty-one deaths are tabulated. Two patients died from sloughing (one of these from tetanus): in Mr. Holmes' 500 cases seven are recorded from similar causes. Two died from secondary hæmorrhage: in the previous tables four are entered. Seven died from shock and loss of blood at the amputation. Two died from erysipelas: in the previous tables five.

Finally, from pyæmia our tables (Table VI, A) show eight cases in 400 amputations; though, as will be mentioned directly, the number might more properly be reduced to four. For the purposes of this table we draw no distinction between septicæmia and pyæmia.

The previous tables show seventy-five deaths from pyæmia in 500 amputations. The contrast is in itself so striking that it needs but little comment. Cases in which pyæmia unquestionably had set in before amputation are not included. In two of our eight cases (5 and 6) pyæmia almost certainly preceded operation, and in one other (7) it probably did so. Yet it has been thought better to tabulate these cases under the pyæmia heading. In the

case of one patient (4), on whom a Syme's amputation had been performed, the heel flap sloughed. This man, who was the subject of cardiac disease, suffered also from carboloria. German surgeons would have set down the death probably not to septicæmia, but to carbolic poisoning.

In Cases 1, 2, 3, and 8 pyæmia seems undoubtedly to have resulted from the amputation. It is noteworthy that two cases occurred in 1876, one in 1877, one in 1880, two in 1883, and finally two in 1886, in patients who were submitted to amputation within three days of each other—a significant fact. At the least this occasional occurrence of pyæmia shows that the battle was not being waged against any imaginary foe. The conditions, whatever they be, tending to the production of pyæmia were there, and were only kept at bay by adequate precautionary measures. To our minds there is absolutely no question that the whole of the improvement as regards the pyæmia is due to the careful carrying out of the antiseptic system. It is a preventable disease, and, as the figures show, has almost entirely been prevented.

Amputations have been taken as a convenient example only of major operations. Statistics of other operations would show the same results. All the details necessary for the thoroughly efficient carrying out of the antiseptic system of surgery can be best practised in hospitals, and it is not, perhaps, too much to assume that, considering the extremely minute risk shown to be run in a well-managed London general hospital, the old spectre of "hospitalism" may be said to be laid.

At the outset of this paper it was pointed out that from 1874 to 1879 inclusive the methods were constantly undergoing slight changes, and that in our tables, unfortunately for purposes of comparison, we are not able to define strictly what may be termed an antiseptic period. Yet it is very significant that the percentage of mortality from 1874 to 1879 inclusive was 26·3 for all cases, while from 1880 to 1888 it fell to 18·8.

If we exclude the cases of death already tabulated as

not really due to amputation, we are left with twenty-one deaths in 341 cases, or a mortality of about 6 per cent. We believe that some such figure represents the real risk of the occurrence of a surgical calamity in an average amputation.

To sum up, then, amputation is practically an operation almost devoid of risk in a selected case, and a person under fifty years of age. After that period of life the danger is greatly increased, though not to the extent shown in the tables, for the gravity of diseases in the old requiring the performance of an amputation chiefly contributes to the increased mortality. Still the risk is undeniably very much greater, even though the dangers arising from degenerated blood-vessels are sensibly diminished by the modern forms of ligatures.

In conclusion we have to thank the members of the surgical staff of the hospital for the ready permission accorded to make use of their cases.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. ii, p. 136.)