On the causes of mortality after amputation of the limbs. [Pt. I. Injuries] / by J.H. James.

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AMPUTATION OF THE LIMBS.

BY J. H. JAMES, F.R.C.S.,

SURGEON TO THE DEVON AND EXETER HOSPITAL, AND CONSULTING SURGEON TO THE EXETER DISPENSARY.

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Surgeon to the Devon and Exeter Hospital, and Consulting Surgeon to the Exeter Dispensary.

The subject of amputation is one which for centuries has in no ordinary degree engaged the attention of surgeons; nevertheless, it has been left to comparatively modern times to estimate, with any approach to correctness, its true relations to life or death. It is since a very recent period we were made fully aware that this operation, till then not regarded as one of remarkable fatality (at least in civil practice), is really more so than the much-dreaded one of lithotomy.* This, however, does not equally apply to military surgery, for its records have always abounded with proofs to the contrary.

The amount of the mortality not duly estimated till of late years, in civil practice.

Mr. Alcock, whose tables are of particular value, from the circumstance that all the cases came more immediately under his own inspection, justly observes, "That a rare combination of circumstances is required to render the observation and registry of a large number of facts, accurately and fully defined, possible;" and he truly states, "that military surgeons have commonly too many obligations imperative upon them to be able to devote the time and concentrated attention necessary." Still, it must be gratefully acknowledged, that it is to military surgeons we have

* Mr. Philips's first paper in the *Medical Gazette*, Nov 14th 1837.

hitherto owed the largest amount of valuable information on this subject; and, among the British, I may especially mention Mr. Guthrie. From the circumstances alluded to, it has probably happened that few of the tables we possess fulfil all the conditions we might desire; and it may be permitted to allude to some points in which they are more or less defective, not, however, confining myself to military tables alone. In some we find amputations of the upper and lower extremities set forth, without distinction of thigh and leg, arm and fore-arm; in some, secondary amputations, truly so called, *i.e.*, for injuries, are not distinguished from those for diseases,—a very important error. In very few, if any, are intermediate amputations specified; often a difficult task, it must be admitted. In amputations for accidents, the particular kind of injury frequently is not stated; for disease, the nature thereof is often not particularized; when death has ensued, the intermediate cause, although frequently given, is also often omitted. To the tables lately published by Dr. Laurie,* Dr. Potter,† Mr. South,‡ and Dr. Steele,§ these objections apply with much less force, to some not at all; and there can be little doubt that a large amount of accurate information will be supplied ere long.

Difficulty in ascertaining the true ratio of mortality.

Principal defects in many of the tables.

More than thirty years' experience, as the surgeon of a large provincial hospital, has enabled me to collect an extensive record of operations of all classes, and among them amputations, of course, form a considerable proportion. The evident desire of the profession to obtain all the information which can be supplied on this subject, has led me to examine that series; and the belief that I may be enabled to contribute some suggestions, usefully bearing on it, has induced me to offer this communication. The accompanying tables contain the result of that experience, but they are defective in many respects. They are constructed from notes of cases, made with no design of publication, and not compiled from any public register; for, until within a very few years (the result of which I have also given) unfortunately none has been kept at our

* *Medical Gazette*, vol. xxvii.

† *Medico-Chirurgical Transactions*, vol. vi. New Series.

‡ Translation of Chelius, with Commentary.

§ *Edinburgh Journal*, No. 146. 1849.

hospital; an observation which applies to most others, as stated by Mr. Phillips; still they contain a considerable amount of valuable information, as I believe, and imperfect as they are, it is perhaps better to make such use of them as they may be fairly entitled to, than to throw them quite away. It may be a question whether I should have published them; there can be none, that it is too late in life to accumulate such an amount of fresh materials. To the tables (in detail, at the end) is appended an explanation of the circumstances of the several cases, which will test their *degree* of claim to statistic value; at all events, it will, I think, be conceded that they afford fair materials to reason upon, *in conjunction* with such data as other sources supply. They commence in the year 1816 and end in 1849, including an even number of 300. These do not comprise all that have been performed during the time alluded to, for there were three intervals when circumstances prevented my recording the cases which occurred, but it is very material that I should at once say, that every one which I have entered during the period stated, has been set forth, otherwise they would be vitiated altogether, for nothing can so much impeach the true value of any record as the suppression of a single fact. I may mention, that of the number, four were in private, but from the peculiar advantages our hospital patients possess, I do not think it would be worth while to exclude them, as I do not believe they were in any respect better off.

Imperfections of my own, and the cause.

Still they may serve as groundwork for reasoning, taken in conjunction with others.

They amount to 300, and include every case recorded in a given period.

Divided into two series, for injury and disease.

These cases I have divided into the two great series of amputations for injury and amputations for disease, which it is becoming the fashion to call pathological amputations; but I shall adhere to old terms, unless when convinced that modern ones are better. The one alluded to is neither shorter nor more definite; indeed, if its application be strictly examined, we shall be at some loss to know how the doctrine of diseases can, with any propriety, be converted into the diseases themselves.

The amputation for injuries,—"the surgical question of the age," as M. Malgaigne terms it,*—will be first considered. They

* *Medical Gazette*, p. 464.

amount to 68 primary and intermediate, and 26 secondary and intermediate. The numbers may not appear large, but yet, comparing them with those which have been recorded in other civil hospitals, they will be found considerable.

Supposing my own records were perfectly accurate, the numbers and results would stand thus:—

Table constructed chiefly from the experience of the Devon and Exeter Hospital, between the years 1816 *and* 1849.

General table of 300 cases.

TABLE I.

	Primary and intermediate.		Secondary and intermediate.		For diseases.		TOTAL.
	No.	*Deaths.*	*No.*	*Deaths.*	*No.*	*Deaths.*	
Thigh	13	8	15	5	118	11	
Leg	18	7	5	1	57	5	
Arm, including three of the shoulder joint, which recovered	19	3	4	1	18	1	
Forearm . . .	18	0	2	0	13	1	
	68	18	26	7	206	18	300

* The proportionate mortality after amputations for disease will appear small, so small, that when coupled with the circumstances I have already stated, it may lead to more doubt than perhaps ought to exist of the average ratio of mortality in our hospital. I am, however, inclined to believe that it is not at all less than facts would prove; and the better to submit this matter to the judgment of those who may take the trouble of considering it, I here subjoin the results of our amputations *since they were regularly registered*:—

Results of amputations registered at the Devon and Exeter Hospital, from Agril 12*th*, 1847, *to November* 3*rd*, 1849.

	Primary.			Secondary.			For disease.		
	No.	*Deaths.*	*Recov.*	*No.*	*Deaths.*	*Recov.*	*No.*	*Deaths.*	*Recov.*
Thigh . .	1	–	1	–	–	–	9	–	9
Leg . . .	4	1	3	1	–	1	6	1	5
Arm . .	1	–	1	–	–	–	–	–	–
Fore-arm .	1	–	1	2	–	2	1	–	1
	7	1	6	3	–	3	16	1	15

Total number, 27. (The result in one case is not entered.) One case is out of danger, but under treatment; I have entered him among the recoveries.

In the foregoing list are not included amputations of any portions of the hands or feet, nor, therefore, Chopart's operation, which I have twice performed with success.

I have here inserted the results of amputations for disease, as in the course of this communication I shall have occasion to refer to them. But my object at present is to investigate the subject of primary amputations; and, in order to bring both the number of our operations of this class, as well as the results, into comparison with those recently published of other civil hospitals, I shall proceed to give the following tables.

Tables of primary amputations. Parisian, from Malgaigne.

In "An exact Extract of all the Amputations practised in Paris for Traumatic Lesions, during a period of ten years, from 1836 to 1846," given by Malgaigne,* it appears that there were:—

	No.	*Deaths.*
"Thigh	44 ..	34
Leg	67 ..	42
Arm and Shoulder	36 ..	24
Fore-arm . . .	10 ..	2
	157 ..	102"

Simpson's, from thirty British hospitals, without anæsthesia.

Professor Simpson having collected the results of *primary* amputations in thirty different British hospitals, chiefly provincial, between the years 1840 and 1847,† without anæsthesia, gives them as follows:—

	No.	*Deaths.*
Thigh .	73 ..	45
Leg . .	80 ..	26
Arm . .	77 ..	17
	130 ..	88

* Extracted from the *Medical Gazette*, Sept. 15th, 1848.

† It must not be understood that this includes by any means the whole number of primary amputations performed at all these hospitals during seven years, as the period given varies much in most of them. Simpson "On Amputation." Table v., p. 11.

From forty-nine, with anæsthesia.

He also collected subsequently the results of the experience of forty-nine British hospitals, under anæsthesia, as follows. (Table i., p. 7.)

	Primary amputations.	
	No.	*Deaths.*
Thigh .	24 ..	12
Leg . .	32 ..	9
Arm . .	17 ..	4
	73 ..	25

But to this table we must refer with some hesitation, for it is probable that some of the worst cases which occurred in these hospitals, not having been submitted to anæsthesia, do not appear in the returns. Professor Simpson's tables include *all* amputations. My reasons for stating the primary only, must be obvious.

London University College Hospital. Dr. Potter.

Dr. Potter, whose valuable life fell an early sacrifice to the duties of our profession, has given the results of sixty-six cases of amputation of all kinds, during a period of six years and a half, at the London University Hospital. They offer only ten cases and three deaths of primary amputations of the different limbs, but they are reported with complete accuracy.*

St. Thomas's. Mr. South.

Mr. South has also given a very full statement of the cases which occurred in his own practice at St. Thomas's Hospital during six years, *i.e.*, from 1835 to 1840 inclusive; they amount to fifty-four of all kinds. Of these, primary, were—

	Primary amputations.	
	No.	*Deaths.*
Thigh .	5 ..	5
Leg . .	9 ..	2
Arm . .	6 ..	0
Fore-arm	1 ..	0
	21 ..	7 †

* *Medico-Chirurgical Transactions*, vol. xxiv., p. 155.

† Translation of Chelius, with Commentary, vol ii., p. 911.

From various sources. Mr. Phillips.

Mr. Phillips, who first called the attention of surgeons to the results of amputation in civil practice, has collected some returns which, from the number of cases they include, it is right to give, but qualified very justly by his own remark,—"I by no means think that the results furnished by such data will fairly represent the mortality."

	Primary amputations.	
	No.	*Deaths.*
Thigh .	245 ..	176
Leg . .	204 ..	88
Arm . .	164 ..	49
	613 ..	313

*

From the Glasgow Infirmary.

Dr. Laurie and Dr. Steele have given exceedingly valuable tables of the results of amputation in the Glasgow Infirmary, for more than half a century, but it materially lessens their value that, from local circumstances, operations of every kind appear to have been attended with a more than usual degree of fatality, so much so that the Governors have been lately induced to erect a separate building, for the purpose of trying how such mortality might be diminished.

Experience of the Glasgow Infirmary from 1794 *to* 1838.

Dr. Laurie.

	Primary amputations.	
	No.	*Deaths.*
Thigh	11 ..	11
Leg	22 ..	15
Arm and Shoulder	26 ..	13
Fore-arm . . .	15 ..	0
	74 ..	39

†

These, I apprehend, are not the whole number of cases treated, but such as Dr. Laurie could depend upon.

* *Medical Gazette*, vol. xxxiii., p. 804.

† *Medical Gazette*, vol. 27, p. 400.

Dr. Steele, in a valuable paper contained in the *Edinburgh Journal,* clxxxiii., has continued the series, and the following is the result:—

Dr. Steele.

	Primary amputations.	
	No.	*Deaths.*
Thigh .	32 ..	21
Leg . .	53 ..	22
Arm . .	49 ..	15
Fore-arm	35 ..	4
	169 ..	62

These tables, together with my own, will suffice to supply materials for the consideration of those points which it will be the first object of this paper to discuss; but it will not be deemed an unnatural course for me to adopt my own as the groundwork, and refer to these in proof of any positions which may require it. I shall, therefore, re-cast my first table with reference to primary and intermediate amputations only, which will then stand as follows:—

Table II.

My own. First division. Primary with intermediate

		Primary and intermediate amputations.*	
		No.	*Deaths.*
Thigh .	Pri.	10 ..	6
„ .	Int.	3 ..	2
Leg . .	Pri.	17 ..	6
„ .	Int.	1 ..	1
Arm . .	Pri.	19 ..	3
Fore-arm	Pri.	18 ..	0
		68 ..	18

* The number of intermediate amputations appeared too small to arrange separately; I therefore threw into this table those which approached most to the character of primary; the others in a similar way I have arranged with secondary.

The mortality after primary amputations,—the causes to be sought.

Having thus set forth the bases of my reasoning, I shall next proceed to a deliberate enquiry into the causes of the remarkable mortality of primary, I may also add, of secondary amputations, as contrasted with those for disease; an enquiry which, as far as I know, has never been systematically attempted, and therefore every allowance must be made, both on the score of its novelty and its difficulty. In the first place, I shall consider the *nature of the injuries* themselves, which has a most material influence on the whole question, and shall therefore state what, upon examination, appears to be the case in this respect as regards my own tables.

Partly in the nature of the injuries themselves.

In the fore-arm the injuries were chiefly occasioned by the bursting of guns, the discharge of small shot through the hand, or laceration by mills of different kinds. In the upper arm a large proportion of the cases also resulted from mill accidents, in which the arm was lacerated or crushed, or both, and in many instances high up.

In the leg the injury has commonly been from heavily-loaded waggons passing over it, or the foot, and consequently crushing it; some from persons jumping from a height; some from the explosion of mines; from heavy weights falling upon the limb; or from crushings in railways. In the thigh the same class of injuries has mostly obtained. The different modes in which these various injuries affect the results, will be hereafter stated.

How far affected by the condition of the recipient.

But, to return to the more immediate causes of death. Of the great excess of mortality after amputations for injury, as compared with those for disease, neither my own tables, nor any others, will leave the slightest doubt. The question is, why is this so? The subjects of operation are commonly of a much more hopeful description than in the latter class. The operation is the same; wherefore the difference?

The subjects of primary amputations, commonly in full health.

Mr. Hunter laid down an axiom which can scarcely be deemed the true* explanation, that health does not brook disease well;† a doctrine, which he expressly

Mr. Hunter's axiom on this point, considered.

* "Fundamental Principles of Information," vol. i., p. 411. "On Gun-shot Wounds," vol. ii., pp. 488, 489, *et seq.*

† The germs of this doctrine may be found in the controversy so ably sustained between the eminent surgeons of France in the last century, *vide* "Boucher, in Mem de l'Academie," vol. vi., *et alibi.*

applies to the question of primary amputations, and it has largely influenced the judgment of surgeons. Two circumstances demand that some enquiry should be made into the validity of this opinion; one, that the facts, at first sight appear to countenance it; another, that any opinion proceeding from such a gifted mind deserves consideration.

In examining the probable foundation for it, perhaps it is not too much to say, that he was led into an error by a too limited view of the matter. The weight of authority at the time he wrote was adverse to primary, and favourable to secondary amputations. His own experience in military surgery was too limited to enable him to form any sufficient judgment. Secondary amputations in civil practice, and performed under *favourable* circumstances, were and are, on the whole, attended with less mortality than primary, (as I may be able to show); and it is probable that, without considering the matter in *all* its bearings, he formed this conclusion.

Not well-founded.

There is, however, one circumstance alone, which would, in my judgment, show that Mr. Hunter's axiom is not well-founded; it is the fact, that many other operations, if performed on the healthy, are attended with better results than in the opposite condition; this may be urged especially with reference to hernia, the removal of tumours, lithotomy, &c.

But although health must be deemed, *cæt. par.*, a favourable circumstance, as regards this and all other operations, yet, if we go further, and compare the results of primary amputations for injury with those performed for disease, the fact is too well established to admit of doubt, that the balance is much against the former; and that, if a soldier, or a robust and healthy labourer, have their limbs mangled by shot, crushed by waggons, or torn by machinery, and amputation is at once resorted to, the chances are more adverse than if the same limbs are amputated for the diseases which befal the feeble, sickly, or aged inhabitants either of town or country, though worn down by pain and suffering, by scrofula, or other debilitating diseases. It must be allowed, that it is an important object of enquiry to ascertain, by careful examination of the facts, and if it may be, by legitimate deduction, *the real cause or causes of the difference*. In arguing this question,

Yet amputations performed for disease on sickly persons are very much less fatal than for injury on the healthy.

I shall chiefly refer to the results of my own experience, and it will be found that in most respects this is not at variance with the facts stated by others.

The first point will be to investigate the more immediate causes of death in the class of primary, and early intermediate, amputations; and it will then be seen that most of them do not apply to cases of amputation for disease. The enquiry will further tend to show the relative importance of each of these causes; and I will now analyze, in a brief table, the primary and intermediate amputations I have given.

On enquiry it will be found that the chief causes of death after amputations for injury do not operate on those for disease.

TABLE III.

		Died from shock.	Died from secondary processes.	TOTAL.
Of amputations of the thigh:—				
Primary were .	10	3	3	
Intermediate .	3	1	1	
Of the leg:—				
Primary were .	17	2	4	
Intermediate .	1	–	1	
Of the arm:—				
Primary . . .	19	1	2	
Of the fore-arm:—				
Primary . . .	18	–	–	
	68	7	11	18

It thus appears, that the direct and destructive impression, which has been designated by the term *shock*, has caused a large

* Dr. Laurie has analyzed the causes of death in seventy-three cases of amputation, p. 403; of which thirty-two were primary (he makes no distinction of intermediate), and of them five only are attributed to shock, twenty-six to secondary processes, one to tetanus; but, unfortunately, no distinction is made of the limbs in each case, as referable to primary, as distinct from secondary or for disease. The large excess of mortality from secondary processes, is probably attributable to the unfavourable air of that hospital.

First, cause of death after severe injuries, whether with amputation or without, is *shock*.

proportion of the fatality of these amputations,* and the fact agrees in a great degree with those related by other more extensive observers, but it may be permitted me to pause for a moment on this important subject. Whether amputation be performed or not, death often results from injuries, either immediately, from the impression made on the system, or if not at once destructive, from its influence continuing to increase till death occurs, the injured part still remaining in connection with the body, and this influence perhaps further increased by hæmorrhage, cold, or other depressing circumstances. Such a circumstance is amputation, and if performed while the state of collapse continues, it is a matter of general assent that it is likely to augment the tendency to death; (yet this is not always so, and I have known it save a patient in whom the symptoms of collapse were increasing, *maugrè* every effort to overcome them.) It may also renew the collapse, when the patient is rallying from it, while, if too long delayed, it may be useless from other causes, as the results of intermediate amputations will show. How many of the cases which perished from shock after amputation would have also perished from the same cause without it, cannot be ascertained, but I shall hereafter revert to the point.

The severance of the injured parts may lessen or increase the effect of shock.

On the other hand, if the additional shock of amputation is, in some cases, calculated to sink the powers further, the severance of the injured part will lessen the influence of a most depressing sympathy, and it is thus often a difficult question to determine in which direction the hope of safety or the fear of death most lies. It is, however, of no small moment to consider the

* (Opus citat.) Dr. Laurie, struck, like myself, with the great excess of mortality in civil, as compared with Mr. Guthrie's returns of military practice, attributes it partly to a cause which I have enlarged upon in a future part of this paper, *i.e.*, the difference in the injuries submitted to amputation in the latter being often less severe; partly to the circumstance of delay and exhaustion subsequently to the receipt of the injury; and partly to the injury involving other parts of the body. The two latter causes are, in my belief, equally applicable to military practice, where circumstances often render immediate assistance impossible, and where the sufferers are not unfrequently the recipients of more injuries than one.

different degrees of influence which an injured limb may exert on the system. A limb may require amputation because a part has been fairly torn away by a cannon ball, or a bone been fractured by musket shot, because a principal vessel has been wounded or a joint opened; and yet, in all these cases, there may have been no great extent of damage to the soft parts and *nerves*; no extensive disorganization, in short, of parts remaining in connection with the body, such as exist when a limb has been crushed, torn, or mashed by mills, cannon balls, wheels of heavy waggons, powerful machinery, &c.* This matter, perhaps, has not been *sufficiently* considered. Many years since some very interesting experiments were made by Le Gallois, in France, and Wilson Phillip, in England, (with no reference to this point), which, however, prove in a very remarkable manner, the extremely depressing influence of a *crushed* state of the *spinal chord*, as contrasted with the mere severance or simple removal. The argument may be applied to those injuries of the extremities whose *quota* of the nervous system, if I may be allowed the expression, is extensively crushed or torn, and the removal of their influence by amputation, may more than counterbalance the effect of the operation in such states of the limbs.

The effects of shock depend much upon the actual condition of the limbs, and that on the nature of the injury.

Experiments of Le Gallois and Wilson Phillip, which prove the very depressing effects of a crushed state of the spinal chord. This, by fair reasoning, may be applied to every part of the nervous system, and consequently to these cases.

The sympathy of the whole with every part, is a subject well understood; but the consciousness (if the expression may be used) of ability or inability to repair an injury, and the results, are also deserving deep attention. This consciousness operates in every abnormal state of the body. It of course did not escape the penetration of Mr. Hunter; but even he has scarcely done it full justice. It would lead me too far to enter largely upon it; but I may mention one or two facts which will explain my own views. A man shall have fractured the lower portion of the cervical spine; respiration, circulation, and digestion, shall go on with little disturbance,

Injuries, by sympathy influence the whole system; that becomes conscious of its degree of ability to repair them.

Instances.

* We find that not only the kind of injury, but the *part*, materially modify the effect. Such injuries of the lower extremities, whether amputated or not, in a large proportion prove fatal; of the upper, especially of the fore-arm, rarely.

his intellectual powers be unaltered, no lesion has occurred immediately incompatible with life, he neither dies of shock, nor hæmorrhage, nor inflammation, *but* he dies almost certainly within three or four days, without an effort or struggle, or any change which indicates speedy dissolution,—he dies from the system being conscious* of an irreparable injury. In contrast with this, is a phenomenon which also often occurs;—as an example, I may mention that the efforts of the uterus shall have ceased after long exertion, yet, if the forceps are brought to aid, those efforts will be powerfully renewed. They ceased, not from absolute want of power, but from a consciousness of inability to accomplish their task unassisted; and they are renewed because there is an instinctive feeling that the effects of that aid will render them efficient for the purpose. It is not pain that excites them. Probably no accident, no disease befals the body, without occasioning what is well denominated sympathy, it may be added, without a *certain consciousness in the system of the task it has to perform,* and its ability to perform it.

Timely aid will impart fresh vigour, by renewing the consciousness of ability.

But to return: although a large number of cases of amputation for injury die from *immediate* shock, yet, *if we substract these,* we shall still find that the proportion proving fatal is far greater than when performed for disease; thus, of the thirteen cases of thigh amputations (primary and intermediate), four died from the secondary consequences; whereas, out of 118 thigh amputations for disease (which I propose to detail at a future period), only eleven died. In the first case, the proportion is 4:13, in the second, 1:10$\frac{8}{11}$. Again, of eighteen leg amputations (primary and intermediate) three died from secondary consequences; of fifty-seven for disease, only five. The proportions, again, are, 1:6 and 1:11 respectively. The difference in the upper extremities is not so great.

After deducting the cases which die from the *immediate* effects of shock, amputations for injury still much more fatal than for disease, from the secondary processes.

Assuming, then, that my tables represent, if not quite accurately,

* It is very remarkable in some cases, how a similar consciousness exists, even in the intellectual being. While some live against every probability, others die, when nothing warrants apprehension, but they will say that they are certain of death, and it befals them.

yet sufficiently for the purpose, the difference in the results of amputations performed for injury, or for disease,* I shall next proceed to follow out, under the head of secondary consequences, the causes of this greater mortality. These secondary consequences are, sloughing and bad suppuration in the part, irritative fever, secondary inflammation, phlebitis, &c. &c., in the system; tetanus must be mentioned, but, although a frequent cause of death in all injuries, it is not especially the result of amputations.† These consequences do also occur, more or less, after amputations for diseases, but evidently less frequently or less fatally.

First, from the amputation being often performed through injured parts.

Now, the first point of difference is this, that in many amputations for injury, the operation is performed through the *injured parts,* and I may observe that this is much more frequently the case in the thigh than elsewhere; and thigh amputations are by far the most fatal, as we well know. In some instances the surgeon has no alternative but to carry his incisions through injured parts; but I may here, with great deference, submit that this is often done when not absolutely necessary, from an opinion which has perhaps been rather too hastily adopted. Amputations for injury in the upper and middle thirds of the thigh are much more frequently fatal than in the lower. Facts prove this to be the case, and it has been assumed that they are necessarily so, although no intelligible cause has hitherto been assigned for the opinion; but the practice, in a large proportion of cases, has been founded upon it, *i.e.*, to amputate in the lower third. If, however, it should appear that the greater fatality arises, not from the

This occurs more frequently in the thigh.

Is the probable cause of the much higher mortality of amputations in the upper portions of the thigh.

* By far the most extensive, and, in many respects, valuable reports with respect to the results of amputation for disease, as distinguished from those for injury, are Dr. Laurie's, published in the *Medical Gazette*, vol. xxvii. The amount of mortality they exhibit, in the practice of the Glasgow Infirmary, is much larger in proportion than my own; but this appears to have been made up, in a great degree, by a very unusual excess of mortality after amputation of the leg (nearly one half), and it must further be borne in mind, that the mortality in the Glasgow Infirmary, after all operations, was remarkably great, as I have elsewhere mentioned, from circnmstances of locality, in all probability, as indeed Dr. Laurie freely allows.

† Out of the sixty-eight amputations, it occurred twice, and fatally; they were both leg amputations.

amputation being performed in the particular region, but, when there performed, it is because the parts are so extensively injured as to render it impossible to amputate otherwise than high, and even then, it may be supposed, often through unsound parts; one great cause of this fatality in high amputations may admit of an intelligible explanation, and a practical inference might be deduced, *i.e.*, that, disregarding any prepossession as to the fatality of such operation, it would be better to amputate high in the limb, through sound parts, than lower, where they are injured. It may be said, that I have no sufficient grounds for objecting to a received opinion, and explaining the facts, as I have done; but I would submit that the point may be put to the test of experience. It is often requisite in amputations for disease to go high up. Are these cases more fatal than others, and, if so, in what proportion? As far as my own observation goes, they are not so; but this might in no long time be ascertained.

In amputations for disease, unsound parts often divided, but the condition of those parts, as regards the ability to repair, intrinsically different.

It may be said, when we institute a comparison between amputations for injury and for disease, especially of the thigh, that in the latter case also the knife often goes through unsound parts; but let us contrast the *different kind of unsoundness*. It may divide parts, it is true, more or less inflamed, in which lymph,—nay, in which pus is effused; but if we reflect on the nature of these processes, we shall at once see that these are merely *natural efforts at restoration*, and the parts are both *disposed* and often able to repair; but in the case of injury, they are torn, mashed, disorganized,—greatly disqualified for such purposes.*

Secondly, the effects of shock are not confined to the immediate impression, but

The *immediate* effects of the preceding circumstances, *i.e.*, shock, on the one hand, and the consequences arising from amputation through parts whose organization and vital powers are impaired, on the other, in producing a great amount of mortality, will be doubted

* Mr. Syme has proposed, as a cause of the remarkable mortality of amputations in the middle of the thigh, the injury inflicted on the medullary membrane; but, independent of other arguments which oppose this opinion, I may mention that the mortality from primary amputations is *proportionably* great in *all* the limbs.

by no one. If, however, I am not mistaken, there is another cause which greatly influences the secondary processes, and it is not only in cases of amputation that the changes, to which I shall presently allude, ensue, but in many other instances, as in compound fractures, severe lacerations, extensive burns, &c. The first symptoms of shock may subside, still we have those of a bad type *in individuals previously healthy;* there is a great tendency to secondary inflammations and suppurations, to phlebitis, and the whole class of spreading inflammations. In injuries unamputated, and in amputations through unsound parts, it might be supposed that the continuance of the connection of the injured parts with the body might be the cause; but I believe I am justified in saying that it often occurs when this is out of the question, where the amputation has been performed above the injury in structures that are *sound.* Why is this? Why does a man die, whose thigh is amputated for an injured foot or leg, although in good health, while a sickly man shall live, most probably, when a similar operation is performed for a diseased joint?

in all cases of injury, whether amputation is performed or not, powerfully influence the secondary processes.

Proof of this is afforded by cases of amputation where immediately performed, and through sound parts.

The immediate effects of violent injury are impressed on every system in the body: the heart falters, the stomach rejects its contents, the liver ceases to secrete, or secretes perverted bile, the nervous system is beat down, and the countenance betrays the deep defailance; clammy sweats, tremors, and other consequences of nervous depression occur; but these all pass away,—these various systems, after awhile, often recover themselves; but still a tendency to diseased action remains, which did not exist before, and this tendency to diseased action is, I believe, produced by the impression made on the system at the time the injury was inflicted, and although the immediate effects, as mentioned above, may pass away, this tendency remains. Whence does this arise? I believe that it does arise from the changes wrought in the *blood* at the time the injury is inflicted, communicated originally through the nervous system, but persisting long after the direct operation of this cause has ceased. This is the real reason why the consecutive

Probable that this arises from changes wrought in the blood at the time the injury was inflicted, which changes are in their nature less transitory than in the other systems.

fever assumes that type, which, for want of a better term (and it is much to be regretted that we have not a better), we call irritation, but whose chief character is want of power. On this subject no one has entered with more philosophical views than Mr. Travers, but I cannot help thinking that the term, in all its phases, although first adopted by the highest authority, and sanctioned by use, is calculated to limit our view of the phenomena to the nervous system especially, to the exclusion of others which may be more really the cause. Be this as it may, the inflammations which occur in various parts will fail to be arrested, as usual, by the adhesive process, and will run into evil suppurations, which, once formed, are so often fatal. Out of a bad material nothing good can be wrought, and I believe that this is the case here. That the blood having once received an impression, or undergone a change, will long retain it, will hardly now be disputed, and everything argues in favour of its being so changed in these cases,—nothing more forcibly than the speedy decomposition of the bodies of persons who die in such a state. The effects of shock, then, may be considered in two points of view, both as *immediate* and *remote*. The immediate effects have been recognized by every surgeon, the remote but little. I should not, however, do justice to Mr. Alcock, if I did not state here, that he was fully cognizant of the remote effects of shock, but he imputes it to a different cause, I mean the state of the nervous system, p. 72, et seq. I am more inclined to attribute it to changes impressed on the blood, for reasons I shall state.

The effects of shock, then, to be considered as two-fold, —*immediate* and *remote*.

No greater authority can be adduced for the fact, that the blood and the general system exert a very powerful reciprocal influence, than that of Mr. Hunter, yet even he was not aware of many circumstances which now seem strongly to evince it. If anything, however, can show the fact in a more forcible manner than another, it is the phenomena consequent on venesection. Even while the blood flows, the *whole* becomes changed; the proportion of fibrine, of serum, of red globules, of serosity, varies in every successive portion that is taken; the period and force of the coagulation vary also every instant,—phenomena which can arise only from the impression continuously produced on the whole mass

Phenomena which evince the more permanent changes often wrought in the blood.

of blood by the hæmorrhage. But it does not stop here; changes not cognizable to the eye also are effected, and often become *permanent*. For example, a person labouring under a long-continued sub-acute inflammatory disease of the lungs, liver, brain, or other organ, if bled, shall, ere a few ounces have flowed, often experience a change in the condition of the inflamed part, nay, of the whole system, and will feel a relief which no diet, no medicine had previously wrought; and, that bleeding, although very moderate, will often effect a *permanent* alteration in maladies of weeks' and months' duration, long after the mere *quantity* lost has been again supplied.

If, then, such impressions can produce such changes, we may be well warranted in believing that a violence, such as these grave injuries I have described, may powerfully affect and pervert the whole mass,—may *disorganize* it, if I may so express myself. The effects resemble those of morbid poison introduced into it. It is not a mere depression of power, a loss of vitality; no amount of evacuation, no degree of exhaustion, will induce such a perverted state. A change ensues in every part of the body; the previously healthy man is converted into a mass of disease. Whether, in such injuries, the limb is separated from the body or not, the system thus changed must work out its own cure, aided by our efforts, as we best may render them.* It is thus that, intermediate amputations failing to change this condition, the patients rarely survive; but, when the powers of the system have conquered this morbid state, when the secretion of pus, and those which are natural, approach to the condition of health, however profuse and however exhausting they may be, the knife will, in a majority of cases, prove a remedy, and the mangled limb be separated with advantage, by secondary amputation.

In these cases of grave injury its state approaches to disorganization.

In cases of injury not involving amputation, although we may have the strongest reason for believing that the destructive changes

* A great many phenomena which are imputed to other causes, such as the supposed absorption of a septic principle for injuries attended with disorganization and consequent sphacelus, may be, with much probability, explained on the principle here advanced. It is clear that no other can explain those which equally occur when a limb has been immediately amputated in sound parts.

Cases of amputation through sound parts afford the best proofs of the fact, that the immediate effects of injury do not cease with the severance of the part, and support the opinion that the blood becomes changed.

described have been wrought in the system, and especially in the blood, by the *immediate* effects of such injury, we have no actual proof that it is so, because the injured parts still remain connected with the body, and, whatever symptoms occur, may be the result of the direct sympathy of the system with the part. The conclusion drawn is probable, but not absolute. When, however, we have such effects following amputation performed for *injuries* of the leg or arm, above the contiguous joint, and shortly after the accident, in parts *perfectly sound;* and, again, when the cause is *disease,* and the surgeon's power of election complete, if we find that *no* such consequences are prone to occur, or, at least, in any similar proportion, we have more conclusive data to work upon. As a question of general pathology it is important, and may throw light on many other morbid phenomena.*

I am aware that the severe consequences which follow injuries and amputations are explained on other grounds, and no doubt they are, in many instances, enhanced, it may be sometimes produced,

* In vol. xxxi. of the *Medico-Chirurgical Transactions* is a very interesting paper by Dr. Hodgkin, bearing on the morbid changes wrought in the blood by local injuries. It was mentioned to me in the summer of 1848, by my friend Dr. Theophilus Thomson, who, being in Exeter, happened to go round the hospital with me; and, in consequence of some remarks I made on the subject, he adverted to this paper of Dr. Hodgkin, recently read to the Medico-Chirurgical Society, but not then published, as I believe. This part of the present paper was then written, and I immediately showed it to Dr. Thomson, and obtained his permission to mention the circumstance, as otherwise it might appear that I had partly borrowed my opinion from another source. I may, however, observe, that although the same *general* principle will perhaps apply to both my own and Dr. Hodgkin's cases, the class and the progress of the symptoms described by him are very different. As regards the former, the injuries were comparatively *slight*, giving rise to fatal changes at *late* periods; in those I have mentioned, the injuries are most severe, the changes most sudden. Perhaps I may be allowed to add, that in these it is not easy to suppose the change is wrought in the mode suggested by that able pathologist, p. 295, *et seq.* The explanation he gives as regards those he describes may nevertheless be quite true. In a very able lecture by Dr. Todd,* analagous opinions as regards the influence of the blood produces on tetanus and other disorders, are advocated by him.

* Lumleian Lectures.

by the foul air of hospitals or other places, and it is a point to which I shall have occasion to revert; but they will and do occur when no such causes can operate, and the remarkable fact is, that they occur in so very much larger proportion after amputations for injuries than for disease, in the *same hospital*, which shows that the principal cause is not the condition of the air; and I may further observe that they rarely ensue (as all the tables show) after the minor case of amputations of the fore-arm for injury, which strongly evinces the truth of the position, that they are in reality the result of the impression communicated to the system, and are just *in proportion* to it.

Tainted air will powerfully influence the secondary processes, but the fact that amputations for dieaseare fatal in a much less proportion in the *same* hospital, shows that theargument may be pursued as regards these cases independently of this consideration.

SECONDARY AMPUTATIONS.

The next point to be considered is, the causes of mortality after secondary amputations. Nothing can differ more than the statements we have upon this point; some tables give a greater, some a less proportion of mortality after secondary than after primary. The first question is, what may be fairly deemed the true period of secondary amputation; the second, the causes which more or less influence the results at this period.

Second division. Causes of mortality after secondary amputations.

It may be assumed that primary amputations include those which are performed at any time subsequent to the receipt of the injury, but prior to the establishment of active inflammatory processes in the part, and corresponding sympathy in the system; that secondary include those when either purulent secretion is fully and normally established in the part, or the processes of sphacelus arrested, corresponding changes having taken place in the system. Again, that those amputations which take place in the intervening time are the intermediate, consequently there is a wide range during which they may occur;* and I believe, with Mr. Alcock,

What may be deemed secondary, what intermediate.

* I believe this statement agrees with the doctrine first laid down by Boucher, Mem. de l'Academie, tome vi., p. 120, and receives the sanction of other great authorities in military and civil practice.

Great differences in the reported results of secondary amputations, partly explicable by including the intermediate.

that one explanation of the discrepancy which exists between the reported mortality of secondary amputations by different surgeons, has arisen from the circumstance that in many cases these intermediate amputations have been classed under the head of secondary. It is very clear that, in proportion as the state of the system approaches more or less to that favourable condition which is selected for secondary amputation, so will the chance of success be enhanced or otherwise. I believe that when performed for spreading inflammatory sphacelus they rarely succeed, although some fortunate cases are related by Larrey,* Lawrence,† and others; but when rendered necessary by sphacelus, produced simply by impeded circulation, from the wound of an artery or vein, or from hæmorrhage (the result of such wound), they much more frequently answer. My own experience is too limited to allow me to draw any certain conclusion;‡ but perhaps the point cannot be better illustrated than by the statement given by Mr. Guthrie as to the results of certain cases after the battle of Salamanca. He states,§ "that of 150 unfortunate wounded Frenchmen, who could not be collected for surgical cure till the period of amputation had passed, forty-six had amputation performed, but of these (chiefly of the thigh, however,) six only were saved." He adds, that those who were not operated on shared no better fate.‖

In what cases the latter succeed.

But commonly are very fatal.

* "Memoirs de la Chirurgie Militaire."

† *Medico-Chirurgical Transactions*, vol. vi.

‡ Of the intermediate amputations I have recorded, three were performed on the thigh on account of sphacelus; of these, one recovered, when it arose from the rupture of the femoral artery; the other two, which were traumatic, died. Of the leg, one was performed for profuse hæmorrhage, the stump being sloughy, and he died. These cases, being at an early period, I have given together with the primary. Two others, amputated at a later period, but before the true time of election arrived, (Nos. 151 and 166), I have given under secondary. In one, a lad of sixteen, there was a wound of the tibial artery, with sphacelus; in the other, a man of seventy, it was performed while sinking from the consequences of a wound of the knee-joint. The first of these certainly recovered, and I have little doubt the second was saved.

§ "On Gun-shot Wounds," p. 59.

‖ Boucher also states, "Of the number of about 150 wounded, whose wounds were in the extremities, those whom we did not think it necessary to amputate at the first period, either recovered without our being obliged to have recourse to it subsequently, or succumbed to the violence of the symptoms in the second, without being able to reach the third." Vol. vi., p. 130, "Mem. de l'Academie."

General agreement as to the mortality of primary amputations. Great discrepancy as to secondary.

Of the great mortality of primary, and more especially of intermediate amputations, there can be no doubt; of the comparative mortality of primary and secondary, there is, as I have stated, a good deal of discrepancy of opinion and statement, from the time of Faure and Boucher to the present period. It will be my next business to enquire into the sources of this discrepancy, and into the more immediate causes of mortality in secondary amputations.

The mortality after secondary likely to be affected by various causes; one very important one, *the long sojourn* of the subjects in tainted air *prior* to the operation.

My own tables, as far as they go, show a less proportionate mortality in secondary than in primary amputations. From the reports of civil hospitals but limited data have as yet been supplied. The valuable report of Dr. Steele, from the Glasgow hospital, is extensive, and, from various causes, demands much attention, but evidently local circumstances have there exerted a very powerful influence. Again, in military hospitals similar circumstances often greatly affect the question. The subjects have (unlike those submitted to primary amputation) been, for the most part, long exposed to the influence of a vitiated air. Often, after a great battle, carried into such hospitals as the emergency alone has created,—churches, convents, and similar buildings; crowded together; poisoned by the atmosphere they breathe, in common with a vast number of other wounded men, and often subject to the influence of endemic or epidemic diseases, their fate is often determined by circumstances foreign to the operation itself. And here I cannot sufficiently commend the system which, from the foundation of our hospital, has been pursued as regards these cases, not only after operation, but before; namely, that they are in the first instance received in large and airy wards, indiscriminately with other cases of every description, so that they are little exposed to the emanations from accumulation of fevered and wounded patients; after the operation is performed, they are placed in smaller, separate, and most convenient wards, where they have a degree of attention on all hands which cannot be surpassed in favour of the highest ranks; are distracted by no groans of other sufferers, or alarmed by their illness

Great success which has attended the system pursued in this respect in the hospital of this city.

or their deaths. If (in addition to surgical care) pure air, kindness, and the absence of injurious causes, can contribute to the well-doing of patients under such circumstances, ours have been for more than a century most fortunate, and to this system of management I greatly attribute the degree of success we have obtained.*

Besides the influence of air and other causes, which will be readily admitted as valid, whenever the case is one of secondary amputation under favourable, as contrasted with those under opposite circumstances, there is another point which has, perhaps, not received its due share of attention as regards the results of civil compared with military practice. In the latter, the injuries which require primary amputation are, for the most part, inflicted by fire-arms; a large proportion compound fractures from *musketry,* and in these the injury is by no means equal in extent, and consequently in degree of shock, to that which occurs in those accidents which, in civil practice, are more generally submitted to amputation,—accidents chiefly arising from the crushing by heavy waggons, blocks of stone falling on the limb, explosions, or from machinery of various kinds, including those of rail-roads. These are similar in nature to the *graver* class of injuries which occur in warfare, from cannon shot, shells, and other explosives; and it would be matter of no surprise, if, on more accurate investigation, the greater number of successful cases of primary amputations in military practice were found to result from the former class, which are rather, perhaps, submitted to operation from circumstances of situation, and the impression which exists as to the consequences to be ultimately apprehended, than because there is an intrinsic evil, too great to be combatted at the moment, while in civil practice this description of case is more frequently reserved for treatment. In comparing, therefore, the results of the one or the other, I think due allowance should be made for the circumstances now adverted to.

The preceding cause, *i.e.*, tainted air, often applies in military practice, but another cause of the greater mortality reported in military returns of secondary as compared with primary, as well as the less mortality of primary in many cases, as compared with the primary in *civil* hospitals, is the greater proportion of severe injuries, which become the subjects of secondary amputation in general military hospitals, and of primary in civil.

* If I am correct in taking this view, it will afford a very strong reason for greater solicitude in future as to the carrying out this important point.

If, then, the results of military practice are liable to be affected by two such important causes as those I have mentioned, namely, first, the number of lighter cases submitted to primary amputation, which would have been placed under treatment in civil, while in the latter only the graver cases fall under the knife;—cases where both the *immediate* and *remote* effects of shock are powerfully adverse, and where injured parts are often left behind; and also, secondly, by the secondary amputations in military practice having been in many instances previously exposed to deleterious influences, quite extrinsic to the operation itself, we may be warranted in concluding that the greater fatality of primary amputations in civil practice, on the one hand, and, on the other, the greater success of secondary, can both be explained.

Instances of the great differences which exist in military practice.

The discrepancy in the results of military practice are great, and, that I may not be considered as overstating it, I shall briefly advert to a few authenticated facts, and these I would rather present as the statement of another than my own. I take, therefore, M. Malgaigne.* As instances of success, I may cite the following:—Percy, out of ninety-two amputations of all limbs, lost only six; Guthrie, at Thoulouse, nine out of forty-seven;† Larrey's military experience, a most extensive one, in various regions, afforded a proportion of three recoveries to two deaths;‡ while, on the other hand, Bilguer says, "among a crowd of persons on whom, during the seven years' war, amputation was performed, scarcely were one or two saved." Faure, "after Fontenoy, ascertained that the success resulting from about 300 amputations was reduced to thirty or forty." In his own campaign in Poland, Malgaigne says he lost all his cases of amputation of the thigh who had fractures from gun-shot wounds.§ These results, he adds, were so contradictory that he was induced to make an exact extract of all the amputations practised in Paris for traumatic lesions, during a period of ten years, from 1836 to 1846, which I have previously quoted.‖ It can neither be supposed that these statements are liable to discredit,

* As extracted from a report in the *Medical Gazette*, Sept. 15th, 1848.

† I see Mr. Guthrie himself, in his Lectures, gives it as ten in forty-eight.

‡ This is the statement of his Aide-Major, M. Blandin.

§ Page 464. ‖ Page 53.

where the precise numbers are given, nor can it be doubted that some explanation of the enormous difference is required. How far that I have now submitted may be satisfactory, is for others to judge; but to the statements already quoted from Malgaigne, I shall add the following recent returns, to show how great the differences still continue to be, under, it may be presumed, considerable variation of circumstances, but with the same class of operators, and the same class of subjects:—"Primary operations performed on the field between June 21st and December 24th, 1813, in the army under the Duke of Wellington,—Lower extremities, 128, deaths, 19."* "Primary amputations performed in the British Legion at Saint Sebastian's, from May 5th, 1836, to June 10th, 1837, —Lower extremities, 20, deaths, 12."† In the returns from civil hospitals the proportions mainly agree; the great discrepancy in military practice may, perhaps, be explained on the grounds I have offered.

In civil hospitals the proportions mainly agree —at least the discrepancy is by no means so great.

I shall next proceed to analyze the results of my own tables of secondary amputations, with the object of pointing out the chief causes of mortality, (as in the first division;) stating, however, that I have not had the same means of ascertaining them as in the primary, since they are apt to terminate at more remote periods, when I had less power of observing them closely. The numbers stand thus:—

Table IV.

TABLE OF SECONDARY AMPUTATIONS.

Analysis of my own tables of secondary amputations.

	No.		*Deaths.*		*Uncertain.*
Thigh (Secondary) .	13	..	5	..	2‡
„ (Intermediate§)	2	..	–	..	–
Leg . . .	5	..	1	..	–
Arm . . .	4	..	1	..	–
Fore-arm . .	2	..	–	..	–
	26	..	7	..	2

* Guthrie "On Gun-shot Wounds," p. 42. † Alcock, p. 95.

‡ Nos. 50 and 83. § Nos. 151 and 156.

This return exhibits a very small proportion of secondary amputations (excepting the thigh) as compared with the primary, and also a smaller proportion of deaths; and, throwing them into a common table, the numbers will stand thus :—

TABLE V.

	Primary and Intermediate.			Secondary and Intermediate.		
	Cases.	*Deaths.*	*Recov.*	*Cases.*	*Deaths.*	*Recov.*
Thigh .	13	8	5	13	5	8
Leg . .	18	7	11	5	1	4
Arm . .	19	3	16	4	1	3
Fore-arm	18	0	18	2	–	2
	68	18	50	24	7	17

Comparison with primary.

Only thirteen cases of secondary amputation of the thigh are included in this table, because I feel so uncertain with respect to the results of two that I think it fair to strike them out.

Affords proof of the restorative powers in the upper extremities.

On comparing these tables, the first remark I should make, is, that of secondary amputations of the fore-arm *none*, of the arm *few*, appear; affording positive proof that injuries of the upper extremities which are reserved for treatment, generally do well, and, consequently that there is great encouragement to try it;—the second, that, with regard to the lower extremities, the cases which reach the proper period for secondary amputations, may be accounted more successful than primary.

Only the best constitutions commonly reach the period of secondary amputation.

Of secondary amputations, it is but right to say, as has been observed by Alcock and others, that only the best constitutions survive, commonly speaking, to have them performed; and, as military authorities show, a large proportion of grave injuries, which are attempted to be saved, die under treatment.

In speaking of primary amputations, I have given several tables from civil hospitals, whose value is not impeached by any circumstance; but I regret to say, that with reference to secondary

The reports from civil hospitals, as regards secondary amputation for injuries, very defective; in military, greatly differing.

amputations, this is not equally the case. Professor Simpson's are of particular importance as regards primary; but from the circumstance of their showing no distinction between secondary amputations for injuries and for disease, that series is not applicable. The Glasgow tables, by Dr. Laurie and Dr. Steele, are exempt from this objection, but they are collected from the experience of a hospital whose local condition is such as to render the criterion an unfair one. I shall, however, give it, as by far the most extensive we possess in civil practice.

*Dr. Steele's Table.**

Secondary amputations for injury.		
	No.	*Died.*
Thigh	18	15
Leg	19	13
Arm	16	9
	53	37

Dr. Laurie's Table.†

Secondary amputations for injury.		
	No.	*Died.*
Thigh	24	16
Leg	5	3
Arm	14	7
	43	37

If we consider that these persons had been subjected to the avowedly tainted air of that hospital for a much longer period than the primary cases, we shall hardly wonder that the ratio of mortality has been so large. I may further add, that I do not see any distinction made between intermediate and secondary.

As regards military practice, the returns are much more copious than in civil; but, of the remarkable discrepancy in their results, arising, probably, from the same general circumstances which have been already adverted to, as regards primary amputations, the following brief statement may be admitted as sufficient proof. Of 255 secondary amputations of the lower extremities, performed between the 21st June and 24th December, 1813, in the Duke of Wellington's army, 149 died;‡ while, in Alcock's work, we find the following passage: "of gun-shot fractures of the leg, not complicated with injury of the joints, there were fifty-seven cases, of which twenty died; *eight underwent secondary amputation, and all recovered.*"§

* *Edinburgh Journal*, loc. cit. † Page 400. *Medical Gazette*, vol. xxvii.
‡ Guthrie, p. 41. § Alcock, p. 53.

If we investigate the causes of mortality in the table of secondary amputations I have given, we shall find that they materially differ from those which influence primary. Of the seven fatal cases, *none died from shock*, all from secondary processes; and if we proceed to examine the nature of the injuries which led to these amputations, we shall also find that they only include a part of those which lead to the performance of primary, and possess less of the character of *crush*. A reference to the detailed table at the end will show, that these secondary amputations were more especially for wounds of joints, hæmorrhage, or sphacelus from wounded arteries; thus, of the thirteen amputations of the thigh, six were occasioned by wounds of the knee joint, producing extensive suppuration; three from injured arteries, with hæmorrhage or sphacelus; and four only for compound fractures.

The analysis of my own tables shows that for the most part the causes were less connected with crush, and no case died from shock, all from secondary processes

I cannot conclude this part of my subjcct without adverting to a very important, but very doubtful question,—the nature of the injuries which require amputation, or, to take it in extenso, the propriety of amputating for injuries. It is well known that Bilguer, dissatisfied with the results of this practice, prohibited it in the Prussian army, and quite recently a surgeon of high eminence in France, Malgaigne, has again adopted the principle. This would not be a fitting occasion to go largely into details on this topic, but I may briefly say, that M. Malgaigne's opinions, previously doubtful on the subject, were finally determined by the facts stated, p. 73; and having adopted a different line of conduct, founded upon the principle of amputating in no case of injury, excepting when complicated with shattered wounds of hip or knee joints, he gives the result as follows:—Fractures of all limbs, 27; cured, 15; dead, 11; one suffered secondary amputation, and in great danger. His colleague, M. Gosselin, treated 25 cases on a similar plan, and had 16 successful. It may be difficult to meet this experience by any authenticated reports by individual surgeons. I find, however, in Mr. Alcock's valuable work, at p. 52, a table which partly meets the question, for out of 21 cases of gun-shot fractures of femur, while

The question of amtation for injuries.

M. Malgaigne's statements.

Mr. Alcock's and Dr. Laurie's.

six (it may be presumed the worst cases) underwent primary amputation, either on the field or in the hospital, 15 were reserved for cure, or secondary amputation; of these six were subsequently amputated. Of the primary amputations, five died; of the secondary, three; of the remaining twelve, eight died, and one remained without hope of recovery. These, too, were promising cases, "fine, healthy, young men," Mr. Alcock says, "to whom my attention was particularly devoted;" and it is not an improbable supposition that the greater proportion of these fifteen resulted from wounds by musketry, and not from cannon; but this is not stated. This may be taken as a strong counterpoise to the success above alluded to.*

Various ill-understood circumstances influence the results of all operations.

In endeavouring, then, to form any conclusion as to the results of operative surgery, we must take fully into account the remarkable variations which are produced by circumstances, often beyond our control, more often beyond our calculation. It is not only the experience of this, but of every other operation, shows it. Lithotomy, hernia, afford many examples of long runs of ill or good success in the hands of one or many surgeons. Local circumstances, peculiar conditions of air, of seasons, of the minds of men, all powerfully contribute to this uncertainty; but I must

* The records of civil practice are very meagre on this point, but to the valuable tables of amputation which Dr. Laurie has given, the following is added, shewing the "Results of compound fractures and dislocations not amputated," p. 401, *Medical Gazette*, vol. xxvii:—

	No.		*Cured.*		*Died.*
"Thigh . . .	5	...	1	...	4
Leg	21	...	15	...	6
Foot and Ankle	5	...	2	...	3
Arm	5	...	3	...	2
Elbow . . .	2	...	1	...	1
Fore-arm . .	2	...	1	...	1
	40	...	23	...	17"

Without, however, more definite information of the cause of injury, and classification as to its nature and extent, I hardly think we are warranted in drawing any certain conclusion from this; and, it must further be remarked, that the same causes which acted unfavourably in the case of amputations, must also in these cases.

differ from Mr. Alcock, who says, (contrasting the results of military and civil experience), "In large civil hospitals more leisure is attainable, but the nature of the injuries is not sufficiently various, and probably no one life would be long enough to register the requisite number," p. 67. For the latter remark, I feel that there is but too much foundation; but my own experience would teach me, that while military practice is limited as to the age of the patients (the prime of life) and the nature of the injuries, civil hospitals have the advantage of embracing every variety, and every age and condition of constitution, and from the very circumstance of their records being expanded over a long series of years, the favourable or unfavourable influence of particular cycles, or especial circumstances, will be merged in the lengthened observation. It can hardly be better shown that I have not over-stated the influence of such causes, than by a reference to Mr. Alcock's own experience. "In the first sixteen amputations performed for gun-shot wounds, consisting of primary and secondary, including a shoulder joint case, the majority of the thigh and leg, I lost but one, and that was an all but hopeless case of secondary amputation of the thigh. In the next eight, I lost seven, and the one saved was a complicated case, requiring amputation at the shonlder joint." Note, p. 96.

The effects of these fluctuations likely to be corrected by the experience spread over a long period in civil hospitals.

Instances of remarkably opposite results in military practice.

I think it necessary here to mention, as connected with the subject of amputation, a very important statement, which I find made by M. Malgaigne, with reference to the effects of treatment, which not only in itself is most important, but also as elucidating the state of depression and disorganization of the blood and general system, after severe injuries. This statement is neither more nor less than the results of treatment of the various soldiers wounded in the engagements which took place at Paris in 1814. I extract the statement from the *Medical Gazette*, Sept. 15th, 1848; it is as follows:—"A document emanating from the administration of the hospitals at Paris, which, it is much to be regretted, has not been published, throws much light on this question, *i.e.*, the deplorable results of a severe diet and emissions of blood. It is

M. Malgaigne's statement as regards the influence of treatment.

the tables of mortality among the different nations received into the different hospitals of Paris."

"In this table figure French, Prussians, Austrians, and Russians. The wounded of the first class were submitted to a severe system of diet; the Russians, on the contrary, were rarely submitted to a single *bouillon*, or more rarely to low diet; the less severely wounded had a full diet, and the rest middle diet, and, in addition, they had wine and brandy. The mortality was—

"French soldiers	- -	1 in 7
Prussian ditto	- -	1 in 9
Austrian ditto	- -	1 in 11
Russian ditto	- -	1 in 27

"This enormous difference is sufficiently eloquent."

It may be presumed that this report, sanctioned by the authority of M. Malgaigne, affords sufficient ground for reasoning upon. If so, it is highly important. It tends very strongly to show that the adoption of lowering methods, the anti-phlogistic plan, as it has been long termed, is not, at all events, the most successful in combatting the inflammations which ensue on injuries, with depressed powers and impaired organization, which, in many cases, are *the* permanent source of danger, and we might as well lower in cases of poison. The rational plan is to treat cases according to their nature and causes, and not to be governed by names. The variety of inflammations is very great, so ought to be the treatment; and on this I have ventured long ago to express my opinion, as also that many tonic and stimulating remedies are really "anti-inflammatory."* The record quoted above strongly confirms this view.

Bears strongly on the question of the nature of the inflammation consequent on these injuries.

There are many other circumstances which materially affect the results of amputations, but which are rather referrable to the mode of performing the operation, and the subsequent treatment, than to general circumstances affecting the whole question. Such, for instance, are the amputations by flap or otherwise, the closure of the wound, the employment of anæsthetic agents, &c.; but as these are, to a great extent,

The mode of operating and treatment of the stump, and other collateral causes affecting the question, may be reserved.

* "On the General Principles, and Nature, and Treatment of Inflammation," p. 186.

applicable to amputations for disease also; and as I may, perhaps, at a future period submit such observations as I may be enabled to make upon that series, I shall not proceed with this branch of the enquiry at present.

SUMMARY IN CONCLUSION.

It may now be permitted me to sum up, in conclusion, the more important points discussed in this paper.

Amputations for injuries are far more fatal than for disease, notwithstanding the subjects are commonly persons in the prime of life and health. The causes are, I believe, to be sought chiefly in the *nature of the injury*, which appears to have a material influence on the result, even when the injured part is completely severed from the body by amputation.

The description of injury which is attended with the most fatal consequences, is that which involves the greatest degree of *crush* or laceration, and this more especially in the lower extremities, partly from the larger mass disorganized, partly from the greater inability of the system to repair the injury, and the consciousness of this inability.

The effects which are produced by such injuries on the system, called shock, as is commonly known, often cause immediate or speedy death; but the impression produced on the system *does not pass away, even if the injured part is completely removed* and the patient survives; and the result is often a series of morbid processes, constituting destructive inflammation in the stump, and in various parts of the body, accompanied with a corresponding febrile disturbance. In these cases we see the *remote* effects of shock; in cases of speedy death, the *immediate*.

If the powers of the constitution are sufficient to overcome these morbid processes, either the patient recovers or is restored to a condition in which amputation may be performed with a fair prospect of success; but if it be performed from any urgent necessity before this period, it is much more frequently fatal. These are intermediate amputations.

The remarkable change wrought in the general system by such injuries is, then, very probably the cause of the great mortality of these amputations, as compared with those for disease. The

functions of every separate system are, doubtless, impaired thereby, but it is also probable that *the blood* undergoes the *more lasting* change, and consequently has the *strongest* influence on the result.

Many other circumstances also influence the result. Such are,—

The age, sex, and more or less healthy state of the patient;

The locality, season, and condition of the atmosphere, and various other extrinsic circumstances;

The more or less complete removal of every injured part;

The mode of operating, and especially the subsequent care; but as these apply in great measure (except as regards the third) to amputations for disease, as well as for injury, they cannot be taken into account in a *comparison* of the two.

The records of civil and military surgery both agree in the great amount of mortality after primary amputations, especially of the thigh; but while the former agree also remarkably as to the proportions, the latter exhibit very great differences, which, it is submitted, may be explained, partly by the ever-varying conditions which attend military practice; partly, by the wounds received in some engagements being inflicted by weapons which produce less or more extensive amount of crush or laceration, as musket balls, on the one hand, cannon shot on the other.

The apparent excess of mortality in civil hospitals, as compared with that in many instances of military practice, admit of explanation, upon the principle that the causes are more frequently of a nature resembling in their effects the latter or severer class.

The great discrepancy which appears in the records of both civil and military hospitals, as to the results of secondary amputations (of which, however, the latter alone offer a large number), may probably be explained, partly, by the unfavourable circumstances in which the subjects of secondary amputation are often placed in military practice; partly, by want of accuracy in distinguishing in these returns the intermediate in contradistinction to true secondary amputations; and it may be considered, that when the subjects of secondary amputations have been exempted from the influence of tainted air, and are submitted to the operation at the *true* period, the results are more favourable than those of primary, while the intermediate are the most fatal of the three.

The circumstances, then, which occasion the respective mortality of different classes of amputation depend less upon the *operation itself* than upon the changes resulting from the injury; and I may hereafter be able to show that amputations for disease are little fatal, if the operation be well performed, and the treatment be suitable.

I may further remark, that a position which has long obtained credit with the profession, namely, that amputation in the two upper thirds of the thigh are, *per se*, more fatal in a great degree than those in the lower, is doubtful. The fact is so, but the cause may be that (in addition to a larger extent of injury), these amputations are accompanied with the disadvantage of being performed through *injured parts*.

The very important and long-agitated question of the greater or less success to be expected from immediate or deferred amputation, in cases of injury, does not at present rest upon sufficient data to enable us to reason fairly upon it, but in the absence of sufficient authentic records, the opinion of a great number of eminent surgeons must be admitted as sufficient authority for preferring the former; and if, in such cases, it be allowable to reason, *a priori*, we should be led to conclude that the sympathetic influence of the comparatively small and well-conditioned surface of a stump, would be less likely to affect the already damaged system adversely, than the mangled mass otherwise left, which can only be retrieved by processes difficult, destructive, and often impossible.

Various methods of operating and of after (local) treatment, considerably influence the results; but, connected with this point, there is one which, from the recent evidence of a great French surgeon, appears of paramount importance,—it is the constitutional treatment of such injuries, a subject which demands the closest observation. It would appear that the system hitherto pursued, most generally, is adverse to recovery.

Facts, carefully observed, recorded, and analyzed, ought to lead to some useful results. Those which bear upon the subject of amputation are now both numerous and valuable. In endeavouring by a careful comparison of those which have fallen under my own observation, with the far more extensive series which, of late years,

have been laid before the public by others, to reduce them to some definite conclusions, I may, perhaps, have assisted in throwing light on the laws which govern this important, but very intricate subject. When, however, I consider that the attention of the most eminent masters of our art has been deeply engrossed in its consideration for more than a century, it becomes me to speak with the utmost diffidence of this attempt to reduce it to some fixed principles. I shall be amply rewarded for my trouble, if it shall be considered that I have in any degree forwarded the great object in view.

TABLE I.—PRIMARY AMPUTATIONS. THIGH, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
58, Case Book, vol. iv., p. 500.	Stout man.	Thigh crushed by waggon; knee-joint opened.	Shortly after he was brought in, on the bed, as he lay. 1826, April 7th.	J.	Recovered.	
67, Case Book, vol. iv., p. 564.	Stout man.	Both legs shattered, by the explosion of a mine.	Not sufficiently recovered for the operation until the morning of the subsequent day. Amputation of one leg and one thigh. 1847, Nov. 24th.	W.	Died on the following day.	
135, Case Book, vol. v., p. 390.	Boy.	Bad compound fracture of the thigh, and otherwise much injured.	Time not specified. 1833, August 28th.	W.	Died in a few hours. He sunk partly from the general injury.	
172, Case Book, vol. vi., p. 428.	Stout man.	Crushed wound into the knee, with obliteration of popliteal artery and vein, by coagulum.	Shortly after. 1836, May 2nd.	J.	Died from phlebitis, which came on twenty days after the operation.	The vein was tied, but no inflammation found after death in that.
177, Case Book, vol. vi., p. 422.	Man.	Compound fracture of leg.	1836, August 8th.	Z.	Stump became sloughy, and sixteen days after the operation stated to be doing ill: probably died.	

TABLE I. (*Continued*).—PRIMARY AMPUTATIONS. THIGH, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
206, Case Book, vol. vii., p. 415.	Lad, 19.	Limb crushed by a thrashing machine.	1839, August 28th.	W.	Recovered.	
267, Case Book, vol. viii., p. 465.	Man, 49.	Knee-joint shattered by the bursting of a small cannon.	Very shortly after. 1846, June 26th.	J.	Recovered.	
277, Case Book, vol. ix., p. 312.	Boy, 13.	Crush of thigh and leg from thrashing machine.	In a few hours. 1846, December 4th.	X.	Survived about a week, and died from irritative fever.	
278, Case Book, vol. ix., p. 315.	Man, 50; feeble.	Leg crushed by a block of stone.	Performed under increasing collapse, which could not be arrested. 1846, December 18th.	J.	Died in half-an-hour.	
287, Case Book, vol. ix., p. 339.	Man, 50.	Laceration of lower part of thigh, extending into the knee-joint.	About four hours after his admission. 1848, January 8th.	Z.	Recovered.	

Thigh.—Ten primary; four recovered, six died; of these, three sunk shortly after the operation, three of irritative fever and the consequences, or phlebitis.

TABLE I. (*Continued*).—THIGH. EARLY INTERMEDIATE AMPUTATIONS.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
150, Case Book, vol. vi., p. 400.	Healthy man, aged 68.	Crushed leg.	Four days afterwards. 1834, May 31st.	J.	Amputation performed during spreading inflammation, but through sound parts. He sunk and died the day after.	In this case, sphacelus was imminent, and the operation was performed on the grounds urged by Larrey, and prior to the spreading inflammation attacking the thigh.
154, Case Book, vol. iv., p. 405.	Stout elderly man.	Crushed leg.	Two days afterwards, a spot of sphacelus appearing. 1834, June 20.	Z.	Died eighteen days afterwards. Stump sloughy.	
38, Case Book, vol. iv., p. 451.	Man, 55.	Rupture of the femoral artery, from the crush of a waggon, and producing sphacelus of the foot and leg.	Twelve days afterwards. October 18th, 1822.	J.	Recovered.	
Three intermediate; two died, one recovered.						

NOTE.—The most important feature in such tables, beyond all doubt, is the record of the results, and in these the results in several cases are not appended; it is, therefore, important that I should state upon what grounds I assume that the cases terminated fatally or otherwise where such an omission occurs. From two causes the deaths after operations could seldom escape my notice, first, because these patients are placed in small separate wards, which I have been in the constant habit of visiting whenever I went round, and it could rarely happen that a death occurred without my knowing it; and, again, I was Curator of the Museum during the whole period, and I felt it more particularly my duty to attend the examination of those who died, when permission to examine could be procured. When a death, then, occurred, it could scarcely escape my notice, and I think it rarely happened that I did not record the fact, especially in such cases as these.

Some cases may have terminated fatally after their removal from the operation wards without my knowing it, yet, as it has been the general practice to allow them to remain in those wards until out of danger, if a patient died subsequently, the result in few cases could be fairly ascribed to the operation. In assuming, therefore, that when no death has been recorded as a consequence of operation, it is not likely to have occurred, I have not greatly erred, in all probability, but it will be found that I have not engaged in any chain of reasoning founded upon *perfect* accuracy; neither my own, nor, as I believe, any other tables yet given, afford such an opportunity.

It is right to add, that in these tables *there is no selection of cases*. I might have contented myself with giving only those which were complete, but the omission of a single case, however imperfectly noted, would have vitiated the whole report. As it is, I have given them in regular order, numbered from the beginning to the completion of 300 cases, referring to the volume, page, subject, accident, limb, operator, and result, when known. Had these points been completely followed out in all instances, little more would have been required. Under the head "Surgeon," my own initial is preserved; the others are arbitrarily adopted, but in every instance are noted in my Case Books under the real name.

TABLE II.—PRIMARY AMPUTATIONS. LEG, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Amputation.*	*Surgeon.*	*Result.*	*Remarks.*
92, Case Book, vol. v., p. 338.	Lad, 17.	Fracture, with laceration.	November 5th, 1849.	Y.	Died.	Tetanus eleventh day.
137, Case Book, vol. v., p. 391.	Stout man.	Crushed foot.	September 8th, 1833.	Z.		
146, Case Book, vol. v., p. 398.	Man, 50.	Laceration and compound fracture from loaded waggon.	April 10th, 1834.	Y.	Died fifteenth day, from spreading inflammation and sphacelus.	
155, Case Book, vol. vi., p. 408.	Healthy young man.	Compound fracture from loaded waggon.	July 22nd, 1834.	W.		
178, Case Book, vol. vi., p. 432.	Man, 70.	Crushed leg by waggon.	August 13th, 1836.	J.	Recovered.	
194, Case Book, vol. vii., p. 408.	Woman, 32.	Compound luxation of ancle, with much fracture and crush, from the wheel of a loaded caravan.	October, 1838.	J.	Recovered.	Six months' pregnant at the time.
200, Case Book, vol. vii., p. 413.	Man, 60.	Compound fracture.	April 21st, 1839.	Y.	Died, April 26th.	This man was paralytic before the accident.

TABLE II. (*Continued*).—PRIMARY AMPUTATIONS. LEG, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
232, Case Book, vol. viii., p. 401.	Man.	Compound fracture.	August 31st, 1848.	Z.	Recovered, October 29th.	
239, Case Book, vol. viii., p. 414.	Boy, 13.	Leg crushed in a flour mill.	May 26th, 1843.	X.	Died four hours after.	
252, Case Book, vol. viii., p. 447.	A. B.	Leg.	February 7th, 1845.	Z.		
260, Case Book, vol. viii., p. 459.	Lad, 19.	Compound fracture, with laceration. The foot mashed in a thrashing machine.	January 5th, 1846.	J.	Recovered, Feb. 14th.	
272, Case Book, vol. ix., p. 306.	Young stout navigator.	Both legs crushed, and both amputated.	November 2nd, 1847.	V.	Died in thirty-six hours.	Collapse increased before amputation, in spite of every exertion. After it he lived 36 hours.
285, Case Book, vol. ix., p. 330.	Man, 56. Unhealthy, with varicose veins.	Compound fracture, produced by jumping off a loaded waggon.	August 2nd, 1847.	J.	Death from tetanus, which came on the 15th day.	
291, Case Book, vol. ix., p. 347.	Lad, 16.	Foot crushed by a railway engine.	May 24th, 1848.	X.	Recovered.	

TABLE II. (*Continued*).—PRIMARY AMPUTATIONS. LEG, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
293, Case Book, vol. ix., p. 353.	Man, 52.	Laceration of foot from a quarry explosion.	August 3rd, 1848.	V.	Recovered.	The collapse continued 36 hours after the operation, but he was saved by great assiduity.
298, Case Book, vol. ix., p. 365.	Boy. 10.	Leg crushed in a paper mill.	December 5th, 1848.	X.	Recovered, Jan. 27, 1848.	
Leg.—Primary, sixteen.	Six died; seven recoveries entered; three believed to have recovered. Of the six who died, two were from tetanus, two from collapse, and two from irritative fever and consequences.					

TABLE III.—PRIMARY AMPUTATIONS. ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
13, Case Book, vol. ii., p. 505.	Young man.	Laceration and crush of the whole arm and shoulder-joint.	1819, June 27th. Shortly after the accident. No symptoms of shock. At the shoulder-joint.	J.	Recovered.	
24, Case Book, vol. iii., p. 498.	Woman, 56.	Lacerated wound of arm (and fore-arm of other side) in a bark mill.	1820, March 25th. Six hours after the accident. Double operation.	Y.	Recovered.	

TABLE III. (*Continued*).—PRIMARY AMPUTATIONS. ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
77, Case Book, vol. v., p. 309.		For injury.	1828, September 8th.	Y.		
111, Case Book, vol. v., p. 361.	Young man.	Compound fracture, and injury of shoulder-joint, in a grist mill.	1832, Feb. 10th. At the shoulder-joint.	W.	Recovered.	
115, Case Book, vol. v., p. 365.	Lad, 16.	Arm and fore-arm crushed in a mill.	1822, May 17th.	Y.		
117, Case Book, vol. v., p. 368.		Compound fracture.	1832, July 27th.	W.		
123, Case Book, vol. v., p. 381.		Lacerated arm.	1833, January.	W.		
125, Case Book, vol. v., p. 382.	Girl.	Compound fracture.	1832, December.	W.		
143, Case Book, vol. v., p. 397.		Laceration.	1833, December 14th.	W.		
144, Case Book, vol. v., p. 397.		Laceration.	1834, March 18th.	Y.		

TABLE III. (*Continued*).—PRIMARY AMPUTATIONS. ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
153, Case Book, vol. vi., p. 405.	Middle-aged man.	Arm lacerated in a bark mill.	1834, June 19th.	J.	Recovered.	It was followed by a very severe attack of diffuse inflammation, and his recovery was long and difficult.
164, Case Book, vol. vi., p. 418.	Boy, 14.	Arm crushed in a grist mill.	1835, August 22nd.	W.	Died within an hour, from collapse.	
179, Case Book, vol. vi., p. 439.	Old man.	Arm crushed in a bark mill.	1837, January 28th.	J.	Died March 20th.	Secondary inflammation and suppuration ensued, and increased during an influenza. He struggled on till the date specified.
181, Case Book, vol. vi., p. 443.		Laceration.	1837, August 2nd.	Y.		
246, Case Book, vol. viii., p. 434.		Laceration.	1843, February.	X.	Recovered.	
257, Case Book, vol. viii., p. 450.	Stout man.	Laceration, with wound of brachial artery and elbow-joint.	1844, June 2nd.	Z.	Recovered.	

TABLE III. (*Continued*).—PRIMARY AMPUTATIONS. ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
264, Case Book, vol. viii., p. 459.	Fine young man.	Severe compound fracture near the shoulder.	1847, February 13th.	J.	Died.	Partly from shock, he having also a comminuted fracture of the other thigh and a lacerated wound of the foot on the same side, which was attacked with diffuse inflammation. He lived ten days.
284, Case Book, vol. ix., p. 323.	Boy, 4.	Arm crushed by waggon.	1847, June 16.	J.	Recovered.	He had great collapse in the first place, and, afterwards, bronchitis and irritative fever, which reduced him much.
299,	Man, 21.	Lacerated and crushed arm, at shoulder-joint.	1849, April 30.	J.	Recovered,	During the collapse which followed the operation an enema with brandy and milk was employed with great benefit.

Arm, 19.—Three died, one from collapse, two secondarily; but in one of these (No. 264) there was extreme injury of other parts. Eight are entered as recovered; of the other eight I have no entries as to the result, but I assume that they recovered, as there is nothing entered to render it probable they did not. It may here be repeated, that I entered operations of every kind in my Case Book as they occurred, with the view that if anything more than usual followed I might make notes accordingly. I assume, therefore, that when no such entries are subsequently made (with few exceptions), these and all other operations were attended with no unusual circumstances. Amputations of the arm were so commonly successful that, generally speaking, I attended less to the details than in the lower extremity.

TABLE IV.—PRIMARY AMPUTATIONS. FORE-ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
12, Case Book, vol. ii., p. 501.	Man, 20.	Gun-shot wound.	1819, January 24th. 3 p.m. Operation at six.	J.	Recovered.	Had irritative fever.
40, Case Book, vol. iv., p. 456.	Boy.	Gun-shot wound.	1822, January 7th.	J.	Recovered.	
41, Case Book, vol. iv., p. 456.	Man.	Gun-shot wound.	1822, January.	J.	Recovered.	
42, Case Book, vol. iv., p. 456.	Man.	Gun-shot wound.	1822, January.	J.	Recovered.	
109, Case Book, vol. v., p. 360.	Man.	Gun-shot wound.	1831, November 5th.	Z.		
147, Case Book, vol. v., p. 399.	Woman.	Lacerated hand.	1834, April 16th.	Z.		

TABLE IV. (*Continued*).—PRIMARY AMPUTATIONS. FORE-ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
157, Case Book, vol. vi., p. 401.	Girl, 17.	Hand crushed between the rollers of a paper mill.	1834, September.	J.	Recovered, October 10th.	
183, Case Book, vol. vi., p. 444.	Lad, 20.	Shattered hand in grist mill.	1837, October 8th.	J.	Recovered.	Had enteritis.
197, Case Book, vol. vii., p. 411.	Man, 54.	Shattered hand in mill.	1839, February 22nd.	J.	Recovered.	
211, Case Book, vol. vii., p. 418.	Man.	Gun-shot wound.	1839, November 10th.	Z.	Recovered.	
231, Case Book, vol. viii., p. 400.	Man, 40.	Laceration in a thrashing machine.	1842, June 20th.	W.	July 2nd, doing well.	Erysipelatous inflammation, but doing well a fortnight afterwards.
247, Case Book, vol. viii., p. 436.	Boy, 8.	Laceration in a bark mill.	1844, May.	X.	Recovered.	

TABLE IV. (*Continued*).—PRIMARY AMPUTATIONS. FORE-ARM, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
249, Case Book, vol. viii., p. 437.	Boy.		1844, June 20th.	X.		
251, Case Book, vol. viii., p. 446.	Boy.	Laceration.	1845, January.	Z.		
261, Case Book, vol. viii., p. 459.	Boy, 11.	Laceration in cider mill.	1846, January 21st.	J.	Recovered.	
275, Case Book, vol. ix., p. 307.	Lad, 18.	Gun-shot wound.	1846, November 14th.	R.	Recovered.	
286, Case Book, vol. ix., p. 332.	Middle-aged man.	Laceration in thrashing machine.	1847, October 5th.	V.	Recovered.	
299, Case Book, vol. ix., p. 367.	Young man, 20.	Lacerated hand from bursting of a gun.	1849, January 23rd.	V.	Recovered.	

Fore-arm, 18.—Of these, fourteen recoveries are entered, and of the remainder *I have no doubt.*

TABLE V.—SECONDARY AMPUTATIONS. THIGH, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
5, Case Book, vol. i., p. 290.	Stout man.	Compound fracture of thigh. Wound of knee-joint, May 4th, 1817, from falling from a tree on an axe.	1847, May 25th. The limb full of abscesses, and his state very bad.	Y.	Died, worn down by irritative fever, June 14th.	Had nearly sunk from collapse after the operation.
23, Case Book, vol. iii., p. 494.	Young man.	A ball lodged in the knee-joint at the battle of Waterloo was removed by a surgeon long afterwards, and gave rise to severe inflammation, and in about five weeks he was brought to the hospital in a very evil state of limb and health.	1820, March 14th, a few days after his admission.	J.	Improvement speedily followed the operation, but there was a considerable struggle. Was made an out-patient June 15th. Recovered.	
50, Case Book, vol. iv., p. 483.		Compound fracture, with sinuses extending above the knee.	1824, July.	Y.		
83, Case Book, vol. v., p. 312.	Young man.	Received a wound in the knee-joint from a hatchet, and was admitted on the third day. Abscesses formed, extending to the upper part of the thigh.	1829, March 26th.	W.		

TABLE V. (*Continued*).—SECONDARY AMPUTATIONS. THIGH, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
87, Case Book, vol. v., p. 331.	Man, 71.	Rode over, July 29, 1829. The horse stepped on his right leg, and he got a compound fracture at the upper part; extensive suppuration occurred, with irritative fever.	1829, August 29th.	J.	Was discharged in the month of October. Recovered.	
103, Case Book, vol. v., p. 352.	Man.	Wound of knee-joint, giving rise to extensive abscesses and much exhaustion.	1831, March.	W.	Died of secondary inflammation.	Amputation in middle third.
151, Case Book, vol. vi., p. 401.	Lad, 10.	Gun-shot wound, June 3, just below the knee; both the tibials and the popliteal nerve were wounded. Sphacelus of the limb occurred, with much constitutional irritation.	1834, June 8th.	W.	June 25th, going on very well. The stump *had* been sloughy and suppurated largely, and his constitution much disturbed.	
166, Case Book, vol. vi., p. 420.	Man.	Middle of Sept., 1835, wound of the knee-joint from the wheel of a cart. Extensive suppurations of the leg and thigh, and great exhaustion.	1835, October 3rd, about three weeks after the accident, on the bed as he lay.	J.	The last entry is Oct. 10, when his state was very doubtful, but, from recollection, I think he recovered.	

TABLE V. (*Continued.*)—SECONDARY AMPUTATIONS. THIGH, IN DETAIL.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
173, Case Book, vol. vi., p. 429.	Man.	Admitted May 21, 1836, about eight or ten days after the accident, which was a laceration of the popliteal artery, without external wound, from the wheel of a large waggon, causing sphacelus of the limb; a line of demarcation formed.	1836, May 28th.	Z.	From the state described of impending dissolution, on July 16th, most probably this case terminated fatally.	
174, Case Book, vol, vi., p. 430.	Healthy country man.	Admitted in consequence of a wound of the knee-joint by a hook, about two months before. Extensive suppurations and high irritative fever when he came in. After endeavouring to improve his state in vain, amputation performed.	1836, July 7th.	J.	Died, exhausted, the end of the month.	
176, Case Book, vol. vi., p. 432.	Man.	Compound fracture; the limb in a very bad state, and the operation necessarily high up.	1836, July 28th. Flap high up.	Y.	Recovered.	
182, Case Book, vol. vi., p. 432.	Lad.	Compound fracture of the leg, followed by extensive suppuration and sphacelus of the integuments.	1837, September 18th.	Y.	October. I believe he did well.	

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
215, Case Book, vol. vi., p. 444.	Healthy man.	Was a case of fractured patella; the joint in a state of suppuration; the upper portion retracted four inches. The suppuration extended high up the thigh. He came in several weeks after the accident.	1840, June 17th.	Y.	Case, I think, did well.	
218, Case Book, vol. vii., p. 428.	Young man.	Compound fracture of leg; extensive suppuration and grave constitutional symptoms; was in a very bad state at the time of the operation.	1840, December 6th.	W.	Early in January the case is entered as doing badly.	
276, Case Book, vol. ix., p. 308.	Man, 40.	Compound fracture of the right leg from fall from scaffold, with other injuries; at the expiration of five weeks there was hæmorrhage, which recurred, and operation performed.	1840, November 20th.	X.	Recovered.	

Thigh, 15.—Three deaths entered; two probably died (173 and 218). Four recoveries entered; four probably did well (166, 176, 182, and 215); two (50 and 83) are very doubtful.

These cases of secondary amputation often sink, after a considerable interval, and when removed to their own wards. I am, therefore, more doubtful about those which are not entered as having died or recovered than about any others, as from this cause I am more likely to be ignorant of the termination. Assuming that the account is correct as to 13, it would give five deaths and eight recoveries; but, then, the nature of the accident is different for the most part from those which gave rise to primary amputations, which were chiefly cases of severe crush or laceration, with fracture. Of the secondary, six originated from wounds of the knee-joint, three from injured arteries, with sphacelus or hæmorrhage, and four only were cases of compound fracture. Of the latter only one, in all probability, died (218). Some of these cases would rather belong to the class of *late* intermediate amputations, as I have elsewhere remarked, such especially are Nos. 151 and 173, which in the note, p. 74, are entered 161 and 156, the latter in error.

TABLE VI.—SECONDARY AMPUTATIONS. LEG, ARM, AND FORE-ARM, IN DETAIL.

LEG.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
7, Case Book, vol. ii., p. 409.	Man.	Compound fracture. Crush.	1819, February 28th, about ten days after the accident.	Y.	In all probability recovered.	
45, Case Book, vol. iv., p. 474.	Woman, 85.	Compound fracture, from fall from a donkey.	1824, February 8th.	W.	Recovered.	
190, Case Book, vol. vii., p. 405.	Man, 40.	Compound luxation of foot.	1838, March 30th, about a month after the accident.	J.	Recovered.	
207, Case Book, vol. vii., p. 416.	Man, 54.	Compound fracture.	1839, September 13th, about three weeks after the accident; the man in a very bad state at the time of the operation.	Y.	Died, October 10th.	
265, Case Book, vol. viii., p. 460.	Young man.	Injury of the ancle, producing extensive suppuration.	1846, March 4th, a very considerable time after the injury.	J.	Recovered.	

Five cases.—Three entered recovered; one, in all probability, died. The number, as compared with the thigh, is small; the number of recoveries, in proportion, large; the only fatal case, a very unfavourable one. All these accidents occurred at a remote part of the lower extremity.

ARM.

No.	*Subject.*	*Accident.*	*Period of Operation.*	*Surgeon.*	*Result.*	*Remarks.*
16, Case Book, vol. ii., p. 522.	Young man.	Sphacelus, from scald.	1819, August 3rd.	J.	Recovered.	
81, Case Book, vol. v., p 314.	Man, 69.	Lacerated hand, with extensive abscesses.	1820, November.	J.	Recovered.	
168, Case Book, vol. vi., p. 417.	Man.	Hand and arm lacerated by the run of a rope, and followed by traumatic gangrene.	1836, February, being about ten days after the accident.	Z.	Recovered.	
188, Case Book, vol. vii., p. 402.	Man.	Hand shattered by the bursting of a gun. Sphacelus ensued.	1838, January, rather more than a fortnight after.	Y.	Died.	The stump having mortified.

Four cases.—Three recovered, one died, namely, a case where amputation was performed for traumatic sphacelus.

FORE-ARM.

186, Case Book, vol. vi., p. 446.		Hand crushed by a heavy roller.	1837, October 31st.	W.	Recovered.	
296, Case Book, vol. ix., p. 359.	Young man.	Laceration of hand, and subsequent hæmorrhage.	1848, October 8th.	X.	Recovered.	

Two cases, both recovered. The comparatively *small number of amputations* of the leg, arm, and fore-arm cannot fail to be remarked; and this must be fully taken into account in estimating the relative mortality shown in table, p. 75, which *otherwise* might appear to show a larger proportion in secondary amputations.