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## LECTURES

ON

## AMPUTATION,

AND ON THE

*Nature, Progress, and Terminations of the Injuries for which it is required.*

(Delivered at Sydenham Coll. Med. School.)

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### LECTURE VIII.

*Comparison of the diseased actions supervening on complicated injuries of the extremities during treatment, and rendering AMPUTATION expedient or imperative, with those defined in previous Lectures as causing DEATH.*

In the last lecture the nature of the diseased actions occurring during treatment in the most severe and complicated forms of injury, and rendering amputation of the limb necessary, were carefully analysed and classed, according to certain general and prevailing characters.

If we compare the character and proportionate frequency of these supervening actions rendering *amputation* necessary, with those already analysed and classed as causing *death*, the conclusions to which I now proceed to call your attention will be borne out by the facts.

In Lecture IV. of this series, I laid before you a detailed analysis of the number of deaths and the causes,—that the comparison may be clear, I will briefly recapitulate the final results.

#### FATAL ACTIONS.

In 192 cases treated, supervening actions caused death during treatment in 38, or one-fifth of the whole number treated.

In these 38 fatal cases, *fever predominated* in 21.

In 18 of defined character—

10 hectic.

5 remittent.

3 continued, intermittent, irritative, 1 each.

3 character undefined.

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No. 917.

Average term of fatal development, 44½ days.

In these 21, 5 presented disease of viscera; 4 were suspected by the symptoms, but the fact not ascertained by examination of the cavities; and 2 had gangrenous limbs.

The class of *irregular or accidental causes*, corresponding with the third class of supervening actions causing amputation, amount to 14 (the causes of death in the remaining 3 not having been ascertained).

Of these, shock, tetanus, and other complicating wounds (causing exhaustion), are in equal numbers, 3 each; a fraction more than one-fifth. Hæmorrhage and gangrene, 2 each; or one-seventh. Angina pectoris, 1. Average term of development, 26½ days.

#### *Diseased Actions causing Amputation.*

The number of these supervening actions during treatment are 52 (see Tables III. and IV.); but in relation to the proportionate number treated, I must refer to Tables I. and II., for 13 of the 52 form a series from a Portuguese campaign: the series of fractures in the same period, and therefore appertaining, are not included in the number of cases treated and recorded in the same tables.

Referring, therefore, to Tables I. and II., the total number of cases not amputated in the first instance, but submitted to treatment, together with the number of those which subsequently required amputation, are thus stated—(see following page).

It appears, therefore, that in nearly 200 cases submitted to treatment, two-fifths of the whole are lost, either in life or limb, by these supervening actions: and in this large series, very nearly the same proportion of deaths take place without operation, as there are cases which require or admit of amputation.

Of the 39 amputations resulting from these supervening diseased actions, 17, or not far from one-half, died subsequently, either by the continued development of the same actions, which the operation may not have succeeded in cutting short; or by actions supervening upon the amputation, which may thus act as a new injury upon the system. The total loss of *life* in the 192

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*Amputations.*

	Total Number of Cases.	Supervening Actions caused Amputation in	Proportion to Cases treated.
Fractures not involving joints.....	131	23	5.6
Ditto implicating joints.....	61	16	3.8
Two classes combined.....	192	39	4.9

In the same series it will be found that the proportion of deaths in the cases where amputation was not performed, is as follows :—

*Deaths.*

	Total Number of Cases.	Deaths.	Proportion to Cases treated.
Fractures not involving joints.....	131	18	7.2
Ditto into joints.....	61	20	3.
Two classes combined.....	192	38	5.0

cases is thus, within a very small fraction, 1 in 3.5, or between a third and a fourth.

For the proportionate frequency of different classes or kinds of supervening actions, and their average term of development, we may return to the Tables III. and IV. of larger numbers, and resume the analysis of 52 instead of 39 amputations. These present several complete series, occurring in certain defined periods; they show, therefore, as faithfully the proportions of one kind of diseased action to the other as the smaller number lately quoted.

The average period at which amputation was indicated by the development of morbid processes in the system or the limb, according to the prevailing type which has been adopted for the classification of kinds, is not devoid of interest, as showing the greater or less degree of gravity and malignancy in different classes of morbid actions, compared with the average fatal development of the same diseases. Where febrile action predominated, the average period for the performance of amputation was 29 days: for more irregular actions, 29½ days. Excluding 2—one at 4 years, the other at 7 months—where the period of performance was a matter of choice to the patient.

The average period of fatal development of febrile actions supervening upon these injuries being 44½ days; and for more irregular actions, 26½ days.

We see, therefore, that the supervening febrile actions which, on an average period of 44½ days, end fatally, if amputation be not performed, demand amputation at an average of 29 days. While the fatal development of the class of irregular supervening actions, at an average period preceding that which generally leads to amputation, obviously indicates the greater severity of the former; and that, in many instances, the suddenness of their appearance, or their fatal character, render amputation, as a remedial means, impossible, or unjustifiable. In other words, the supervening “irregular actions” are shown to be of a more fatal and less manageable character as causes of death, than when

they appear as causes of amputation, and that it is only in the milder forms that this alternative is offered.

In reference to these supervening actions, local and general, which I have classed as “irregular, having peculiar or specific characters,” and leading to amputation, trismus gave rise to that measure, twice at 8 days and once at 10 days.

Death was caused in 2 at 7, and in 1 at 48 days.

Secondary hæmorrhage in 7 led to amputation at the following periods:—3 at 13 days; 1 at 11; at 34, 50, 77 days each: average period, 50 days.

Death was caused in 2; at 84 and at 34 days: average 59.

The average period of occurrence in the 9 is 37½ days.

This is a result for which, I believe, many in the profession are not prepared. The usual period for the occurrence of this dangerous complication of gunshot wounds, has hitherto been fixed by military writers at 10 or 12 days. Within this period only 1 took place, and even within 30 days only 4, or less than one-half of the whole.

I can fully depend upon the accuracy of these data; and I may confess that, until I began to labour at these statistical results, I was scarcely myself prepared to find an average period so remote from the infliction of the wound. In reference to this complication of injuries of the extremities, I may observe, however, that there are two very distinct causes of secondary hæmorrhage. The first arises from the separation of sloughs at the commencement of the suppurative process, and the disgorgement of all the tissues, allowing a free passage for the blood through any ruptured point, which may have been the result of the passage of a ball.

The second, from the pressure of a spicula, or end of a shaft of bone, first producing slough, and then rupture; or inflammation, and ultimately ulceration; or, finally, by a spicula protruding through the coats of an artery: occasionally, but more rarely, from the extension of an ulcerative or gangrenous

action, from the adjoining tissues to the coats of an artery.

The first causes generally produce hæmorrhage before the 15th day, rarely after the 20th; the second may occur at any period during treatment, and generally after weeks or months.

In the series quoted of fractures of the extremities, it appears as a cause of death in the proportion of 1 in 96; as a cause of amputation, 1 in 27.4.

Sloughing or gangrene is common, both as a cause of death and of amputation. The other divisions do not offer results of such importance as to require remark or further explanation.

By comparing the resumé already given of "causes producing DEATH without amputation," and "supervening actions necessitating AMPUTATION," it will be evident that the general features or characters chiefly differ, in the large predominance of fever, in distinct types in the former. Although some analogy exists in the proportion of the different classes, examination will also show that some causes produce death, which do not appear as causes of amputation; such, for instance, as shock; complicating wounds in other parts; secondary abscesses, and chest affections; and in any future records it seems probable that tetanus would disappear from the list of supervening actions proving causes of amputation. I have had sufficient proof to carry conviction to my own mind, that it never arrests the fatal action when once developed; but either by the exhaustion of the second shock more rapidly destroys the patient, or should he so far recover as to allow reaction, that the nervous system is still more violently affected.

Some actions there are which necessitate or lead to amputation, but not to death. Such are contracted and useless limbs, or limbs so subject to pain from the lodgment of balls or other sources of irritation, as to induce the patient to seek relief in operation.

*On the Differences and Resemblances between the Causes of Amputation in Fractures simply and in Fractures involving Joints.*

I am disposed, for a moment, to draw attention to this analysis rather as furnishing data on which to build hereafter in any subsequent inquiries directed to this subject, or as facts which may prove useful when added to, or compared with others than from any very striking feature brought out in the present series.

CAUSES OF AMPUTATION.

*In Gunshot Fractures not involving Joints.*

- 13 General and local bad actions without specific characters, or the case decided to be hopeless, and delay appearing dangerous.

- 7 Secondary hæmorrhage.
- 3 Sloughing and gangrenous action.
- 3 Tetanus.
- \*1 Suppurative disease disorganising limb.
- 1 Disease of periosteum.
- \*1 Mortification of limb below.
- 1 Deficient and sluggish character of actions at seat of injury.
- 1 Contracted hand—ball-lodged.

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*In Gunshot Fractures, extending into the Articulations.*

- 16 Local and general bad actions without specific characters.
- 2 Gangrene.
- 1 Pain and permanent inconvenience in locomotion from lodgment of ball.
- 1 Periosteal disease.
- \*1 Local unhealthy action chiefly.

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The most remarkable circumstance here is the fact, that all the cases of secondary hæmorrhage occur exclusively in fractures not implicating joints; although the close proximity of the axillary, brachial, popliteal, and other arteries, would seem to place them in not less jeopardy in fractures of the articulations. *Tetanus* also is confined to the one class—fractures.

The causes of amputation in the intermediate period, from the 3rd to 19th day, both inclusive, and the secondary performed at any time subsequent, present some differences not unworthy of note.

CAUSES OF AMPUTATION IN INTERMEDIATE PERIODS.

*Supervening Actions causing Intermediary Amputation.*

- Number of amputations, 27.
- 17 Rendered necessary by unfavourable actions, general and local, but not of specific character, or on evidence being obtained that the cases were hopeless from the nature of the injury.
- 3 Trismus.
- 2 Sloughing and gangrenous action of part, or whole, of the whole limb.
- 1 Bad and sluggish local action.
- 4 Secondary hæmorrhage.

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*Causing Secondary Amputation.*

- Number of amputations, 25.
- 12 Unfavourable actions not of specific characters, &c.
- 2 Periosteal disease.
- 3 Sloughing or gangrene.

\* These three included in local and general bad actions in the analysis of Lecture VII.

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- 3 Secondary hæmorrhage.
- 2 Bad local actions.
- 1 Contracted hand ;
- 1 Pain and inconvenience in knee on locomotion ;—in both from lodgment of ball.
- 1 Mortification of foot.

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Tetanus was never made a cause of secondary, although in three instances of intermediary amputation ; secondary hæmorrhage may be considered as equally divided, for in one of the four secondary amputations the hæmorrhage came on before the 20th day, although amputation was deferred for some time. Gangrene preponderates among secondary amputations. Upon the whole, more causes of specific character, which may be classed among those “irregular or accidental,” are presented as causes of secondary than of intermediary amputation. In the latter they amount to one-third ; in the former to more than one-half.

I have thus shown, by careful analysis, what are the supervening actions causing amputation : 1st, in their largest classification ; 2ndly, in reference to two great classes of injury,—“fractures into joints,” and “fractures *not* involving the articulations ;” 3rdly, in reference to periods at which operation was required. It still remains to be shown how these are modified by the *nature of the case*, as regards its being of a favourable nature for treatment (having reference, therefore, both to *degree* and *kind*), or of a doubtful or unfavourable type.

### *In 13 Favourable Cases for Treatment, which required Amputation.*

- 2 Local and general actions not of specific character.
- 4 For secondary hæmorrhage.
- 2 For periosteal disease.
- 2 Pain and contraction from lodgment of balls.
- 1 Unfavourable local action.
- 1 Sloughing and gangrenous action.
- 1 Trismus.

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### *In 16 Doubtful Cases for Treatment, ultimately Amputated.*

- 7 Local and general actions, not of specific character, or the hopeless nature of the case demonstrated.
- 2 were for secondary hæmorrhage.
- 2 Excessive local disease, sloughing.
- 1 Gangrene.
- 1 Bad and sluggish action of limb.
- 2 Tetanus.
- 1 Mortification of foot.

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### *In 23 Unfavourable Cases for Treatment, ultimately Amputated.*

- 20 were performed for local and general actions of no very specific character, or from the hopeless nature of the case being demonstrated during the progress of treatment.
- 2 For sloughing.
- 1 For secondary hæmorrhage.

—  
23 Unfavourable cases.

16 Doubtful.

13 Favourable.

—  
52 Total amputated.

It will be observed, that in favourable cases certain well-defined and specific causes, partaking of the character of irregular or accidental results, lead in the great majority to amputation. In doubtful cases, again, although a large proportion of the amputations have a similar cause, yet not far from one-half is from general and local deterioration, having no very distinct character, but evidently pointing to the hopelessness of further attempts to save the limb. In the much larger number, however, of unfavourable cases, nearly seven-eighths are amputated from the hopelessness of conferring benefit by treatment, and not from any specific or peculiar action supervening. Hence, it seems a legitimate inference, that when favourable cases are selected for treatment, only such of them will require amputation as may become the subject of some of these accidental or irregular complications ; but in *doubtful* cases nearly one-half may be expected to require operation by the mere result and natural progress of inflammatory and suppurative processes. When *unfavourable* cases, by any adverse circumstances, or error of judgment, are submitted to treatment, seven-eighths of the whole, in which an opportunity occurs for amputation, will require it from the mere hopeless nature of the injury, and its consequent and natural progress from bad to worse.

The influence upon the diseased actions supervening on complicated injuries, of the external collateral circumstances under which they are treated, and of the site of injury, are deserving some notice ; and, first, let us consider the effects of “external circumstances.”

The Tables, from IX. to XV. inclusive (see pp. 604, 714—16), have been formed for the express purpose of showing the influence of these circumstances upon the cases, rendering amputation necessary in very different proportions. The same number and series already analysed, with other views, are here classified.

For the sake of brevity, I shall include in one class the “unfavourable” and “partially unfavourable,” and compare their results with those treated under favourable circumstances

The supervening actions rendering amputation necessary in 33 cases treated under favourable, and 19 under more or less unfavourable circumstances, admit of the following classification :—

*Under Favourable Circumstances.*

- 16 Bad actions, local and general, of no very specific character, either depriving surgeon of hope of cure, or rendering amputation a safer measure.
- 2 In anticipation of fatal actions, cases unfavourable for treatment.
- 3 Mortification—gangrenous or sloughing actions.
- 5 Secondary hæmorrhage.
- 2 Tetanus.
- 2 Pain and inconvenience from lodgment of balls.
- 1 Diseased state of limb generally.
- 2 Periosteal disease.

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*Under more or less Unfavourable Circumstances.*

- 10 Bad actions, local and general, &c.
- 1 In anticipation.
- 2 Mortification, sloughing, &c.
- 2 Secondary hæmorrhage.
- 1 Tetanus.
- 2 Diseased state of limb generally.
- 1 Low and deficient action.

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The elements are the same both under favourable and unfavourable circumstances,

some slight differences existing only in the proportion of one kind of diseased action to another.

About one-half of the amputations in each are caused by those actions, local and general, which obviously indicate amputation, as the best and often sole resource ; the remaining half are caused by peculiar, irregular, or accidental diseased actions. Secondary hæmorrhage seems most frequent under favourable circumstances ; and this apparent and unexpected result is rendered more difficult to account for by reference to the nature of the injuries, 21 of the 33 are fractures into the articulations. We have already seen that in the whole of these injuries there is not one case of secondary hæmorrhage. Mortification, sloughing, low action, or excessive local disease, preponderate in cases treated under unfavourable circumstances, and indicate the kind of influence chiefly exercised as regards any change in the nature of the supervening actions. The real and most important effect of favourable or unfavourable circumstances during treatment is not to be sought for in the changed nature of the supervening actions, but in the comparative frequency with which amputation is required under each, and the mortality in cases treated, but not amputated.

In a previous lecture I pointed out the proportionate number of amputations under different circumstances, and in connection with the deaths of the same series in cases not operated upon.

Thus to recapitulate the chief results (see vol. i., p. 778) :—

	Amputations.	Deaths in Cases not operated upon.
Under favourable circumstances for treatment, the proportion was .....	1 in 3.4.....	11.8
Under partially unfavourable.....	1 in 9.5.....	2.1
Under unfavourable ditto .....	1 in 8.1.....	3.7

As the proportion of amputations diminish, it will be seen the mortality in patients not amputated is increased, the combined disastrous results being under the three conditions, as 1 to 2.7, 1.9, 2.5 ; that is, they are nearly equalised as regards the two extremes of favourable and unfavourable circumstances, with this essential distinction, that under favourable circumstances only one-twelfth of the number forming the combined result are deaths in cases treated, the rest being made up of amputations ; whereas, under unfavourable circumstances, this is nearly reversed, 1 in 3.7 dying, and only 1 in 8 being amputated.

These, therefore, are the most prominent effects of the influence of external circumstances upon treatment and amputation ; and thus is explained the otherwise unintelligible increase of amputations under favourable circumstances. Under different circumstances, amputations and deaths change their relative

proportions, the one supplying the other's place. The combined results of death and amputation only varying by the fractional difference between 2.763 and 2.230 (taking the two more or less unfavourable together), the real and important difference lying in the proportion of amputations to deaths.

The following conclusions, therefore, it appears to me, is placed beyond doubt, viz. :—

The favourable or unfavourable nature of external circumstances under which cases are treated, shows its influence by diminishing the number of amputations in proportion as they become unfavourable, and in a much greater proportionate number increasing the number of deaths in those treated without operation ; for while it diminishes the number of amputations more than one-half, from 1 in 8.7 to 1 in 3.4, it nearly quadruples the deaths, raising them from 1 in 11.8 to 1 in 3.

*Influence of SITE upon those Supervening Actions which render Amputation necessary during Treatment.*

5 *Lower Extremity above the Knee.*

- 3 State of limbs chiefly, but both local and general bad actions.
- 2 Secondary hæmorrhage.

12 *Involving the Knee-joint.*

- 1 Local bad action leaving no hope.
- 1 Ditto gangrene of foot.
- 8 Local and general actions inimical to cure without peculiar or specific characters.
- 1 Pain and inconvenience from lodgment of ball (at end of four years).
- 1 In anticipation of local and general bad action—limb incurably injured.

10 *Tibia and Fibula above Ankle.*

- 1 Secondary hæmorrhage, with local and general bad action.
- 1 Local and general bad action.
- 3 Chiefly in anticipation of the full development of bad actions commenced.
- 1 Bad and deficient action.
- 1 Mortification of foot and ankle.
- 2 Tetanus.
- 1 To arrest destructive action on system.

4 *Involving Ankle.*

- 2 Chiefly local, unfavourable action.
- 2 Anticipating full development of local and general bad actions commenced.

1 *Upper Extremity involving Shoulder.*

- Unfavourable action, chiefly local.

6 *Humerus above the Elbow.*

- 4 Local and general bad actions.
- 1 Secondary hæmorrhage.
- 1 Extensive periosteal disease.

2 *Involving Elbow.*

- 1 Periosteal disease.
- 1 General and local bad actions.

9 *Forearm.*

- 2 Sloughing and gangrenous actions.
- 1 Contracted hand.
- 1 Bad action, local and general.
- 3 Secondary hæmorrhage.
- 1 To anticipate full development of bad actions.
- 1 Tetanus.

2 *Wrist.*

- 1 Local and general bad actions.
- 1 Sloughing and disorganisation.

1 *Foot.*

- Bad local and general action.

This view of the supervening actions, causing amputation in the upper and lower extremities at different points, is not without interest.

If we compare the actions in the lower extremity from the hip to the knee inclusive, with the upper from the shoulder to the elbow, the relative number being seventeen and nine. In the lower there is gangrene of foot—no such action is produced by the in-

juries in the upper; periosteal disease appears twice as a cause of amputation in the upper extremity; not once in the lower; trismus appears in neither; secondary hæmorrhage equally in both. Local and general bad actions without peculiar or specific characters, appear also equally in both.

Below the knee, including ankle and foot, there are 14; below the elbow, including wrist and hand, 12.

More than one-third of the amputations of the lower extremity are performed to anticipate the full development of actions, respecting the bad consequences of which no doubt can have been entertained. In one instance only was this done in the forearm and hand, indicating how much less risk attends the attempt to save in the latter than the former. Secondary hæmorrhage preponderates in the forearm, hand, and wrist, as 3 to 1; sloughing and gangrenous action appears in both, but mortification of the extremity of the member in the leg alone.

I shall conclude by recalling to your memory certain facts brought out in the last lecture, showing merely the *general* results (the details of which are now before you) of two sets of physical influences in combination, in developing and modifying diseased actions supervening during treatment on *complicated fractures*, and rendering amputation of the limb necessary; viz., 1st, the favourable or unfavourable nature of the injury; 2ndly, the favourable or unfavourable nature of the external and collateral circumstances under which treatment was conducted.

The proportion of amputations under combined favourable or unfavourable conditions may be thus shortly recapitulated:—

	Proportion of Amp. to No. of Cases treated.
In favourable cases treated under favourable circumstances.	1 in 4.
Ditto, unfavourable ditto . . . .	1 in 1.7
Doubtful cases under favourable circumstances . . . . .	1 in 1.4
Ditto, unfavourable ditto . . . .	1 in 2.
Unfavourable cases under favourable circumstances . . . . .	1 in 2.8
Ditto, unfavourable ditto . . . . .	1 in 6.2

On the conclusions to be drawn from these results, I have already sufficiently dwelt in a preceding lecture.

I have now brought before you the various series of facts which serve to define the nature and extent of influence of numerous physical and appreciable conditions, such as the nature and degree of the injury, the external conditions under which treated, &c., in reference to the two principal disastrous results, *Death and Amputations.*

In my next lecture, I shall pass on to the consideration of other and less appreciable, although certainly not less important, influences: those hitherto dwelt upon have been *physical*, there yet remains to be investigated the class of *Dynamic or Vital Influences.*