

the calculus he found. It is this which constitutes the difference in the results arrived at by the two surgeons respectively. Whether this latter calculus was a fragment which escaped the experienced hand of Civiale, or whether it was the product of a new formation, makes no change as to the fact of these results; but it still remains that Sir Henry Thompson put an end to the cruel sufferings of the King, which M. Civiale was never able to accomplish. I have already established in this letter my incredulity as to the supposed "return" of the calculous affection, on which Civiale insists so much. Langenbeck, Thompson, and Wimmer all joined in that opinion; and I have not the slightest recollection that they ever considered the calculus, which was the object of their operations, as a "return," or as a new formation.

There is a passage at the end of Civiale's paper which demands especial remark from me. It is there said, "In order to calm the apprehensions of the King, he was given to understand that the stone was merely a fragment which had remained behind since the former operation, and had become fixed in the walls of the urethra." This is inaccurate and incomplete. King Leopold I. was not a man one might dare to soothe by questionable statements. His Majesty had, in truth, after the departure of Civiale, a fragment embedded in the superior parietes of the urethral canal; but, independently of this, we never concealed from his Majesty the real state of affairs as regards the bladder.

All that I have related in this letter of "the case of King Leopold I." cannot, as far as regards the facts, be contradicted by those who had the honour to surround his Majesty during his illness, or those who have been in communication with his Majesty by writing. I might call to witness Sir James Clark and Sir Wm. Jenner among his physicians, as well as many other persons not belonging to the medical profession. As to the opinions I have here expressed, they may be erroneous, but they result from my convictions.

I beg you, Mr. Editor, to accept the expression, &c.,

DR. G. DE KOEPL,  
Formerly Surgeon-in-Ordinary to his Majesty  
Leopold I., King of the Belgians.

Graz, Austria, December, 1869.

Dr. Wimmer, Physician-in-Ordinary to his Majesty Leopold II., who was associated in attendance on his late Majesty throughout the whole case, having carefully perused the above, writes to signify his entire assent to all therein contained.

## ON THE EFFECTS OF THE ANTISEPTIC SYSTEM OF TREATMENT UPON THE SALUBRITY OF A SURGICAL HOSPITAL.

BY JOSEPH LISTER, F.R.S.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF EDINBURGH.

(Concluded from p. 6.)

BUT, returning from this digression, I must now speak of pyæmia after the major amputations, before and after the introduction of the antiseptic system.

The hospital records are unfortunately imperfect for one of the three years immediately preceding the antiseptic period. In the other two years, the mortality after amputations in my wards may be gathered from the following tables:—

*Before the Antiseptic Period.*

1864.

Seat of Amputation.	No. of Amputations.	Recoveries.	Deaths.
Shoulder ...	1	0	1
Arm ...	3	1	2
Forearm ...	3	2	1
Thigh ...	1	1	0
Leg ...	4	3	1
Knee ...	2	1	1
Ankle ...	3	2	1
Totals ...	17	10	7

1866.

Arm ...	2	1	1
Elbow ...	1	0	1
Forearm ...	2	2	0
Thigh ...	4	0	4
Knee ...	6	4	2
Leg ...	1	1	0
Ankle ...	2	1	1
Totals ...	18	9	9

On the other hand, we have—

*During the Antiseptic Period.*

1867.

Seat of Amputation.	No. of Amputations.	Recoveries.	Deaths.
Arm ...	1	1	0
Forearm ...	2	2	0
Knee ...	2	2	0
Leg ...	1	1	0
Ankle ...	1	1	0
Totals ...	7	7	0

1868.

Shoulder ...	1	1	0
Forearm ...	2	2	0
Thigh ...	1	1	0
Knee ...	8	5	3
Ankle ...	5	5	0
Totals ...	17	14	3

1869.

Shoulder ...	2	2	0
Arm ...	2	2	0
Forearm ...	2	1	1
Thigh ...	1	0	1
Knee ...	3	2	1
Leg ...	3	3	0
Ankle ...	3	3	0
Totals ...	16	13	3

Comparing the aggregate results, we have—

Before the antiseptic period, 16 deaths in 35 cases; or 1 death in every  $2\frac{1}{5}$  cases.

During the antiseptic period, 6 deaths in 40 cases; or 1 death in every  $6\frac{2}{3}$  cases.

These numbers are, no doubt, too small for a satisfactory statistical comparison; but, when the details are considered, they are highly valuable with reference to the question we are considering. This is especially the case with amputation in the upper limb, where neither injuries requiring primary amputation nor the operations involve, as a general rule, much loss of blood or shock to the system; so that, if death does occur, it is commonly the result of the wound assuming unhealthy characters. It happens that there were 12 amputations altogether in the upper limb in each of the two periods referred to. Of the 12 cases before the antiseptic period, no fewer than 6 died—a frightful mortality certainly. And it is recorded that, of those 6, 4 died of pyæmia, and 1 of hospital gangrene. Also that one of those which recovered had pyæmia; but, though the symptoms were well marked and severe, presented an example, unhappily too rare, of recovery from the disease.

Very different was the result of the corresponding amputations during the antiseptic period. Eleven of the 12 cases recovered; and the one death which did occur was not the result of the operation, but took place in spite of it, from pyæmia, which had resulted from fetid suppuration in a metacarpal bone, and continued after I had removed the hand, in the faint hope that the constitutional mischief might be thrown off when its original source had been taken away. Some of the successful cases, I may add, were by no means favourable subjects for operation: as, for instance, a completely shattered hand in a very aged person; the avulsion by machinery of nearly the entire arm, one of the flaps of the amputation at the shoulder-joint being left confused and lacerated as it had been formed by the injury;\*

\* This case was treated by my colleague, Dr. Dunlop, during my temporary absence.

and, again, an enormous osteoid cancer of the upper end of the humerus, involving the deltoid muscle, and permitting only the formation of skin flaps, attended with profuse hæmorrhage, in a patient already anæmic from the disease.

In the lower limb, 28 amputations in all were performed during the antiseptic period. Out of these, death took place in 5; but was generally sufficiently accounted for by the severity of the case, as when the thigh was amputated immediately below the hip-joint in a patient greatly exhausted by hæmorrhage from malignant disease; or, to take another example, when primary amputation was performed at the knee on one side, and immediately below it on the other, in a man who had sustained very severe injuries to both legs, and had been transported a considerable distance by railway to Glasgow.

In one case only did pyæmia result from the operation—viz., after amputation at the knee in a young man of weakly constitution, where putrefaction occurred in the stump through mismanagement. Here the symptoms of pyæmia presented themselves during life, and the femoral vein was found loaded with pus on dissection. When putrefaction occurs after such an operation, there is no security against pyæmia, even in private practice; and a single instance of the kind in three years, and that in a feeble subject, is certainly no evidence of any peculiarity in the hospital atmosphere.

In mentioning the fact that putrefaction occurred from mismanagement, I do not wish to be understood as implying that it can always be avoided in stumps. In the present state of surgical practice, this is far from being the case. When sinuses exist in connexion with a diseased joint, putrefaction is present in them at the outset; and even if they are injected with an antiseptic solution before the operation, it can never be certain that the liquid penetrates to every recess of these often complicated passages, or destroys the vitality of the putrefactive organisms, lurking, perhaps, in portions of lymph or slough. And if a single such organism remain alive, it will propagate and spread in the wound as soon as the antiseptic applied at the time of the operation has been absorbed into the circulation; and any external antiseptic dressing will, under such circumstances, be of course entirely nugatory. It is, I suspect, for want of bearing this point in mind that disappointment has often been experienced in applying antiseptic treatment to amputations and excisions. The full possible benefits of the system can never be obtained in such cases till it shall be deeply impressed upon the profession and the public that abscesses, more especially those in connexion with diseased joints, must never either be allowed to break of themselves, or be opened without antiseptic precautions.\*

I am bound to add that there is another respect in which the antiseptic principle has not yet had justice done to it in the larger amputations in the lower limb. Of all incised wounds, these have proved the most difficult to manage; and putrefaction has repeatedly occurred in my practice, even where no sinuses were present. It was so in the two cases above referred to, of amputation just below the hip-joint for malignant disease, and double primary amputation for injury. Considering the condition of those patients on the day after the operation, I believe both would have recovered had we succeeded in avoiding putrefaction, which, apart altogether from the risk of pyæmia, terribly aggravates formidable cases, like those, by the irritation and prostration which it occasions. Hence we may fairly look for better results in the future from amputation in the lower limb. For I am satisfied that the difficulties of the antiseptic management are not insuperable. I have devoted much attention to this branch of the subject during the last twelve months, and steady progress has been made in it; so that the proportion of stumps in which healing has taken place without any deep-seated suppuration has been

markedly increasing, and I anticipate that before long we shall be able to reckon with certainty on the absence of putrefaction in all cases where sinuses are not present.

But to return to the subject of pyæmia. The two cases above alluded to were the only instances of its occurrence in my department during the antiseptic period. One of them requires further notice here. It belonged to a class of injuries in which the benefits of the antiseptic system have been conspicuously apparent—namely, severe contused wounds of the hand or foot, such as are very frequent in a great centre of manufacture like Glasgow. Formerly there were no injuries more unsatisfactory to deal with. The uncertainty of the extent of the damage inflicted by the contusion made it a most perplexing question where amputation should be performed. On the one hand, if too little was removed, sloughing of the flaps ensued, or diffuse suppurative inflammation of the weakened tissues infiltrated with extravasated blood; and, on the other hand, if it was determined to avoid that error and to amputate through perfectly sound tissues, an extravagantly large portion of the limb was often sacrificed. It is therefore an unspeakable satisfaction to be able to avoid amputation altogether in such cases, merely taking away such portions as may be actually destroyed, and leaving the weakened tissues in the vicinity to recover themselves quietly, instead of perishing under the irritating and poisoning influence of putrefaction; while any dead portions that may remain are absorbed more or less completely, like the extravasated blood, and replaced by tissue of new formation. If the history of all the contused wounds of the hands and feet that have been treated in my wards during the last three years were recorded, including many compound fractures not reckoned as such in our classification and several compound dislocations, it would be enough to convince the most sceptical of the advantages of the antiseptic system.

But the case to which I am now alluding was an exception to the general rule of satisfactory progress. It was a severe injury to the hand from machinery. My then house-surgeon, who had only just entered upon his office, and had not as yet the confidence in the antiseptic system which he soon afterwards acquired, took it for granted that I should amputate the hand, and committed the error of leaving it till my visit on the following day, without adopting efficient antiseptic measures. When I saw the case I decided to try to save the greater part of the hand, and endeavoured to correct the mistake which had been made. Putrefaction, however, ensued, and after some days pyæmia occurred, and continued, as before stated, in spite of amputation of the hand. On dissecting the parts, one of the metacarpal bones was found split up, with putrefactive suppuration developed in its interior. Under such circumstances pyæmia might occur in a perfectly sound constitution and in the most healthy atmosphere, just as, in Cruveilhier's highly instructive experiment, suppurative phlebitis of the femoral vein and its branches, exactly corresponding to that which is seen in traumatic pyæmia, was induced in a healthy dog by introducing into the vessel a bit of wood which, from its porous nature, could not but originate putrefaction.\*

Considering, then, the circumstances of the only two cases of pyæmia which have occurred in my department during the three years of the antiseptic period, I am justified in saying that the wards have been completely freed from their former liability to this frightful scourge.

Next of erysipelas, a disease which, though not so fatal as pyæmia, used not unfrequently to occasion death amongst my patients. During the antiseptic period several cases have been admitted into my wards from without, but one only has originated in them. This occurred in a young man with disease of the foot, accompanied by sinuses extending into the leg. I performed amputation at the ankle, but putrefaction continued in the sinuses; and after the lapse of a considerable period erysipelas occurred in connexion with them. He recovered from the complaint, and after a while went to his lodgings for change of air, with the sinuses still unhealed, and subsequently had another attack of erysipelas there, implying that the tendency to it was in his own system rather than in the locality. That such was really the case was afterwards fully demonstrated. The sinuses refusing to heal, and disease recurring in the

\* The practice which I have found to answer best in amputations and excisions in parts affected with sinuses is, after injecting the sinuses with a powerful antiseptic, to apply to the cut surface a pretty strong solution of chloride of zinc (say forty grains to an ounce of water), such as was recommended by Mr. Campbell De Morgan, and then employ an external antiseptic dressing, in the hope, though never in the certainty, that putrefaction will be avoided. Chloride of zinc, having the peculiarity of producing a remarkably persistent antiseptic effect upon the cut surface, protects it during the dangerous period preceding granulation, when the recently divided tissues are both sensitive and prone to absorption; so that even if putrefaction does occur, the risk of inflammation and pyæmia is greatly diminished.

\* See Cruveilhier's Anatomie Pathologique, livraison xi., where will also be found the records of important experiments, proving how readily liquids introduced into the interior of bones pass into the general circulation.

bone, he was readmitted under my care, and I performed amputation in the leg above the sinuses. The stump healed without any deep-seated suppuration, presenting a very good example of the result of a modification of Mr. Teale's method of amputation; and I requested him to ascertain, by Mr. Teale's plan of introducing circular pieces of flannel into the socket of the artificial limb, how much of his weight he could conveniently rest upon the end of the stump. As he did not call to report the result on the day arranged, I inquired into the cause, and learned that the stump had been seized with a third attack of erysipelas, although perfectly cicatrised without sinus or sore of any kind.\* Thus, as regards erysipelas, our only exception to perfect immunity from the disease during the three years was one that strikingly proves the rule.

It remains to speak of hospital gangrene. This was formerly both frequent and severe amongst my patients. It often grievously marred the most promising results of surgery, and sometimes committed fearful ravages. Thus, I have known a boy admitted with a small superficial wound near the elbow, in which hospital gangrene occurring caused such destruction of tissue, deeply as well as superficially, in spite of the most energetic treatment, that it became necessary to amputate the limb. Now and then it led to a fatal result, as in one of the amputations before referred to. In that case I removed the arm at the shoulder-joint for injury in a boy, and for some time all went on well, till I regarded him as perfectly safe; but hospital gangrene came on in the stump, and, advancing insidiously in all directions, defied my best attempts to check it, and had reached beyond the sternum before the poor fellow sank exhausted from its effects.

The contrast under the antiseptic system has been most striking. For the first nine months, as before mentioned, we had not a single case of the disease. Since that time it has shown itself now and then, but in a mild form, invariably yielding to treatment, never occurring in recent cases, but only in old sores weakened by the influence of surrounding cicatrix. But even this has been very rare, and I do not recollect more than one example of it during the last year. In short, hospital gangrene, like pyæmia and erysipelas, may be said to have been banished by the antiseptic system.

Such being the case, I have insensibly relaxed in different ways my former vigilance regarding the wards. I have allowed cribs for children to be introduced without remonstrance, having practically the effect of increasing the number of beds for adults; and I have, in the pressure of deficient accommodation, often permitted two children to be put in one bed—a thing which I should formerly not have thought of. I used to make a point of having both the large fires in each ward kept alight night and day during the heat of summer, for the sake of making the ventilation as perfect as possible. But during the last season the nurses were left to follow their inclination, and keep only one of the fires lighted. I may add that my wards have remained during the three years without the annual cleaning, which used to be thought essential. On my asking the superintendent the reason for the omission, he replied that, as those wards had continued healthy, and there was nothing dirty in their appearance, it had seemed unnecessary to disturb them. Thus the wards have been in various respects subjected to greater trial than usual, and yet have remained, as I may repeat without any exaggeration, models of healthiness.

That such should have been the case under the unfavourable hygienic conditions above referred to seems at first sight very surprising. The immediate vicinity of a burying-ground such as has been described, together with the position of the wards at the base of an hospital of four stories, with the air confined by neighbouring buildings, may seem conditions utterly inconsistent with health in the patients. That these circumstances were very unfavourable is undoubtedly true; and that they were highly injurious before the antiseptic period seems clearly indicated by our experience. But a little consideration will show that it is not unreasonable to suppose them of secondary importance—as aggravators of the evil, rather than the essential causes of it. The corpses in the places of sepulture beside the in-

firmly were for the most part covered by at least some inches of earth, which has a most powerful effect in checking the evolution of noxious effluvia; and even the foul gases from the open pits were perpetually diluted by the air with which they mingled, so that but a small proportion of them would enter the wards; and accordingly, when the patients were cleared out for the purpose of the annual cleaning, there was nothing in the wards to offend the nose. But the emanations from sores are poured directly into the confined atmosphere in which the patients are; and anyone familiar with the faint sickly smell commonly perceptible in surgical wards under ordinary treatment, and still more with the stench which prevails at the time of the daily dressing, will readily understand that putrid exhalations from the patients may be a source of mischief, compared with which the other circumstances alluded to may be of comparatively trifling consequence.

With the object of getting rid of this great evil as much as possible, I have used antiseptic means, not only where they are of essential importance for the treatment of the individual case concerned, as in recent wounds and abscesses, but also in superficial sores. For though granulating surfaces will commonly heal well enough under a putrid dressing (for such the cleanly water dressing becomes within a few hours of its application), every case so treated furnishes its quota to the vitiation of the general atmosphere of the ward. Hence, for the sake of the inmates generally, it is obviously desirable that healing sores should be dressed with some application which, while permitting, or, if possible, favouring, cicatrisation, should prevent odour. For this purpose some dressing, unstimulating, but at the same time persistent in antiseptic action, is requisite,—a combination which I have sought in various different forms to obtain, and, of late more especially, with very satisfactory results, so that while the healing of superficial sores proceeded with greater rapidity than under water dressing, all my sixty patients might sometimes be dressed without the odour of putrefaction being perceptible in one of them.

The result of this great change has been such as to demonstrate conclusively that the exhalations from foul discharges are the essential source of the insalubrity of surgical wards; and that when this is effectually suppressed, other conditions, which we are accustomed to regard as most pernicious, become powerless to produce serious evil.

It is obvious that the facts recorded in this paper are of extreme importance with reference to the vexed question of hospital construction. With the view of assimilating the atmospheric condition of our large hospitals to that of a private dwelling, it has been lately proposed to do away with them altogether in their present form, and to substitute for them congeries of cast iron cottages, capable of being occasionally taken down, cleansed, and reconstructed,—a plan which, besides involving enormous expense, would interfere most seriously with efficient supervision of the patients, and with the teaching of students at the bedside. But from what has been related above, it is plain that no material alteration of the existing system will be required. We have seen that a degree of salubrity equal to that of the best private houses has been attained in peculiarly unhealthy wards of a very large hospital, by simply enforcing strict attention to the antiseptic principle. And, considering the circumstances of those wards, it seems hardly too much to expect that the same beneficent change which passed over them will take place in all surgical hospitals, when the principle shall be similarly recognised and acted on by the profession generally. The antiseptic system is continually attracting more and more attention in various parts of the world; and, whether in the form which it has now reached, or in some other and more perfect shape, its universal adoption can be only a question of time. The noble institutions of which our country is justly proud, admirably adapted alike for the treatment of the sick and the instruction of the student, will then be cleared of the only blot that now attaches to them,—the malignant influence of impure atmosphere.

Edinburgh, December, 1869.

EXPERIMENTS for ascertaining the effect of inoculation as a preventive of pleuro-pneumonia are being carried out under the direction of the Cheshire Chamber of Agriculture.

\* This case seems to me to possess considerable interest, as something intermediate—as it were a connecting link—between traumatic and idiopathic erysipelas.