FRIEZE IN FAÇADE OF PATHOLOGICO-SURGICAL SECTION OF THE POLICLINIC IN ROME: LISTER.

LISTER. THE INVESTIGATOR AND SURGEON.

BY

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THE first Lister Memorial Lecture, established under the International Lister Memorial Fund, was delivered by Sir William Watson Cheyne, Bt., before the Royal College of Surgeons of England on May 14th. The full text, with an appendix, will shortly be published by Messrs. Longmans, Green and Co. In the course of his lecture Sir William Watson Cheyne said:

The story that I have to tell, though it goes back for just sixty years, is still full of vitality; it is a fascinating tale, far exceeding in interest the most exciting detective story ever written. And it is a true story. It is the story of a fight against a series of diseases—the infective or septic diseases of wounds. Until Lister's time any wound of the skin, whether the result of an accident or of an operation performed by the surgeon, involved a very great risk to the patient of serious illnesses. A surgical ward in a hospital was a place in which most of the patients were visibly ill, with flushed faces, parched lips, delirium, severe pain, etc., and many of them were evidently on the verge of death; the wards were pervaded with a peculiar mawkish odour which was very trying to newcomers. Lister's first introduction to septic diseases was when he became a dresser in the surgical wards at University College Hospital, London. I think that his very first case had been attacked by phagedaenic gangrene, one of the most terrible of these septic diseases. That and other similar cases impressed him so greatly that he never forgot them, and always felt that no study was more urgent or might be more fruitful than the attempt to find out the cause.

When Lister became professor of surgery in Glasgow and was appointed one of the surgeons at the Glasgow Royal Infirmary, late in 1861, he had done excellent experimental work on the early stages of inflammation, coagulation of blood, etc.—work which was to be of the greatest value to him in future and for which he had been elected, at the early age of 33, a Fellow of the Royal Society. Lister made an extensive experiment in his wards with ordinary cleanliness, but without success, and one can imagine his depression when he found that the best methods he could think of did not help him at all, and that pyaemia and all the other septic troubles dogged his footsteps and rendered his best work nugatory.

But it so happened, though Lister did not then know it, that the cause of putrefaction was being revealed about the time that he was appointed professor of surgery in Glasgow. About 1860 Pasteur not only closed the proof against the spontaneous generation of yeast cells, but also opened up a new and extremely vital line of research by pointing out that other fermentations than the vinous, such as the butyric and the putrefactive, were also dependent on living organisms. Pasteur himself does not seem to have had at the time any idea of the importance of this part of his

investigations, and as far as I can ascertain only three men thoroughly realized it, or at any rate made any attempt to utilize the knowledge, within the next few years. These men were Jules Lemaire, Spencer Wells, and Joseph Lister.

Jules Lemaire was, I fancy, of the type of the delightful old learned family doctor. He had no surgical hospital appointment. He at once saw that Pasteur's statement was of great importance, and wrote on the bad effects which might arise from bacteria; he washed his wounds with various antiseptics, notably carbolic acid, with the view of hindering the growth of bacteria in the discharge, but never suggested, as Lister did, that these antiseptics should be used to kill the germs before they got a footing in the body or in the wound.

In 1864 Spencer Wells, one of the pioneers in ovariectomy, in an address at the meeting of the British Medical Association,* gave a most excellent description of Pasteur's work and its bearing on surgery. He was a great practical surgeon and a bold operator, but, curiously enough, he did not follow up the logical conclusions he drew from Pasteur's works. Indeed, his only remark as to the practical application of the work was that "surgeons should always secure the most scrupulous cleanliness and purity of everything surrounding them"; as regards any other treatment, he advocated the internal administration of sulphites.

The third man, so far as I can find, who took up Pasteur's work was Joseph Lister. I understand that he was walking home with his colleague Professor Thomas Anderson, the professor of chemistry in Glasgow, one afternoon towards the end of 1864, discussing putrefaction and its causes, when the latter suggested that he should read certain papers on fermentation and spontaneous generation which had been recently published by a rising young French chemist, Louis Pasteur. Lister, who naturally was not conversant with chemical literature, at once got these papers, and from their perusal he found that it was not the gases of the air that the surgeon had to fear but minute living particles floating in the air and settling on surrounding objects in the form of dust, and that so long as these particles were excluded from the putrescible material after it had been boiled putrefaction did not occur. When the protection was removed and the dust was allowed free admission, minute bodies belonging to the lowest class of vegetable life could be seen swarming in the fluid, and putrefaction very quickly set in.

The conclusion was that some of the particles excluded by filtration or destroyed by heat were actually living germs, which, as they developed in the putrescible material, set up the putrefactive fermentation, just as the vinous fermentation was only set up on the admission of living yeast cells.

* BRITISH MEDICAL JOURNAL, 1864, vol. ii, p. 381.

Lister's application of Pasteur's statements was (1) that these germs must be prevented from getting into wounds during and after operations, and that they must be killed if possible outside the wound; (2) that if they have succeeded in getting into a wound before the case is seen by the surgeon, as in compound fracture, they must be killed if possible before they have had time to spread and secure a footing, and further germs must be prevented from entering the wound afterwards. Lister's method of dealing with the information gained from Pasteur's work was thus more definite and more drastic than the suggestions of the other two surgeons referred to, and reflects the action of the philosophical and experimental type of brain.

He was mentally well fitted for the task which he had undertaken. He had one of the attributes of genius well developed: he did not overlook apparent minutiae. Nor was he led away by the absurd copybook proverbs—"There are exceptions to every rule" and "The exception proves the rule." If he found an exception to a supposed rule he wanted to know why; he did not pass it over as if it were merely an exception and of no consequence. Pasteur had this faculty perhaps still more developed, and Koch in a lesser degree; with all three some part of their success depended on the fact that they were not content to regard deviations from the ordinary course as trifling, but wanted to know why these deviations occurred, and in doing so came across unexpected and helpful information.

Further, Lister had a very logical brain and a very open mind; he was ready to modify his views and plans at once if proper evidence demanded it. He was full of sympathy for suffering, and would devote himself to the relief of a patient without consideration of time. I think that probably his greatest characteristic was his conscientiousness. Before he took action on any point he turned the matter over and over in his mind so as to be as sure as possible that his action was right. He determined to test the theory first in compound fracture, and in cases where only a short time had elapsed before they came under the care of the surgeon, because the prognosis in compound fractures was so bad that it could not be made much worse, and might be improved.

I need not go into the eleven cases which he published in his first paper. The results presented a great contrast to those that he had been obtaining previously, though I think it doubtful whether true asepsis, as we know it now, was obtained in all of the cases. (Five of the eleven undoubtedly followed an aseptic course.) I may mention one or two observations that he made on these early cases which were new to him and of the greatest interest and importance.

In the first place these cases gave him a high opinion of the value of carbolic acid for his work; indeed, it is very interesting that this substance, chosen more or less at haphazard, has turned out to be the most useful all-round antiseptic. Put shortly, only two of the eleven cases developed phagedaenic gangrene—a smaller proportion than usual; but the point that he makes is that in one the disease developed after he had left off the use of the carbolic acid, which he thought had done its work, and in the other it broke out at a small wound which had been overlooked and had not been treated with carbolic acid at all, and had spread from this little wound to the lower part of the bigger wound before it was noticed. In both cases recovery took place, but after a long struggle.

More important was the behaviour of blood clot in aseptic wounds. He mixed carbolic acid with the blood and torn tissues and thus left a mass of coagulum and shreds of tissue in the wound, and several points quite new to him were observed. He noticed (1) that the clot did not contract and break down as he was accustomed to see, but remained firm and adherent to the sides of the wound; (2) that a piece of the clot examined microscopically after some days contained numerous connective tissue cells, some in bundles; later on blood vessels began to develop; (3) that pieces of dead tissue mixed up with the clot also became infiltrated with these connective tissue cells, so that not only did organization occur in the dead clot but also in the more substantial pieces of dead tissue as the result of the penetration of these connective tissue cells into them and the subsequent disappearance of the dead tissue; (4) that, in

some cases, after two or three weeks the edge of a thin layer of clot on the surface could be lifted up, disclosing a layer of epithelium spreading over the clot just below the surface and completing the process of cicatrization.

These points constitute the process of healing by blood clot which we have taken advantage of ever since in cases where we could not conveniently bring the edges of the wound together. Curiously enough this point seems to be lost sight of almost completely at the present time. The other day I picked up copies of four recently published books on general surgery, and in only one of them was there any mention of organization of blood clot. This is a pity, though I doubt if exposed blood clot could be kept aseptic for a sufficient length of time to permit organization where the technique of the surgeon excludes the use of chemical antiseptics.

I may now pass on to the beginning of the session 1872-73, when I first became acquainted personally with these matters. I began the actual study of medicine in May, 1871, and devoted myself for the first eighteen months to botany, natural history, and chemistry, and a junior course of anatomy. In October, 1872, I took out the classes of surgery, physiology, and anatomy. There was an interval between the classes from 12 to 1 o'clock. My lodgings were a considerable distance away, and what I wanted was shelter from the biting east winds and the wet. At that time there was no Students' Club at Edinburgh as there is now, and the only thing I could think of was to sit in the general library. But it was small and crowded with students of all faculties, and there was no chance of a shy youth like myself getting a seat. So it occurred to me that I might as well take out my hospital ticket in October, 1872, as in the following May, which would have been the usual time; in going round the hospital I might learn something, and anyway I would get shelter.

I shall never forget the first day that I went to the hospital. At 12 o'clock I crossed the road to the infirmary and found crowds of students hurrying along the lobbies—a good many, indeed, running. I joined the company, full of curiosity, and found that we were going to Lister's clinical lecture. We ultimately reached the large operating theatre and found it filled with men crowding the gallery and standing at the back and in the gangways; there must have been over 200 there, and they were senior men, for the clinical surgery class was not usually attended till the fourth year. Presently a man walked into the arena, sat down on a chair placed on the floor of the theatre, and, crossing his legs and putting his right hand on his thigh, he began his lecture. This man was Lister. He had not spoken many minutes before I became fascinated with the subject and could not help seeing the wonderful era that was dawning for surgery. I had my notebooks for the other classes in my hand, and as he spoke very slowly and clearly and I scribbled very quickly, I was able to take down practically the whole lecture, though, not having learnt any surgery, I did not understand it at all clearly at first. And thus, simply seeking shelter from the "cauld blasts o' Auld Reekie," and not knowing that I had met my fate, I became entranced by the wonderful vision laid before us by Lister.

Is it any wonder that I left the theatre an enthusiast for the profession I had chosen, and that on lecture days I was one of those who ran? An enthusiast I still remain. On my way home that first afternoon I bought a superior notebook, into which, as soon as I got home, I copied out my notes of Lister's lecture and all that I could remember, looking up the words I could not understand in my textbook on surgery. This I continued to do after every lecture, and this notebook, containing Lister's lectures for the winter session 1872-73 and part of the following summer session, I have presented to this College, and it will be found with the Lister relics.*

* In his lectures Lister tried to show and discuss examples of as many different surgical diseases (even the simplest) as came to his clinic, so that in the course of the session the students had seen a considerable variety, especially of the ordinary cases which turn up in private practice. In my notebook we find among other things spinal caries, varicose (with operation), epulis, spina bifida treated by drainage, suprapubic lithotomy (probably the first case performed for many years), excision of elbow, simple fracture, burns, ununited fractures with operation, stricture of oesophagus, stricture of the urethra, malignant tumours of jaw, naevus, hypospadias, cancerum oris, fistula in ano, strangulated hernia, etc.

At that time, and until Lister left Edinburgh, the rivalry among the students—between Lister's followers and those who continued the old system—was very marked. The Listerians, who were considerably the more numerous, looked on the non-Listerians as lost souls, Tories of the most die-hard description, and not likely, when they came to practise their profession, to be able to give their patients the best chance possible. The non-Listerians, on the other hand, looked on the others as crazy believers in vain things like germs, rash to a degree, blinded with their enthusiasm, placing their patients in the greatest danger by the outrageous treatment that they proposed, and, as they said that their wounds did not suppurate while those of the other side did, liars of the first water. This rivalry increased for a considerable time, and when I became Lister's house-surgeon in Edinburgh, in 1876, it was probably at its height. It was, I believe, of the greatest value to the cause of asepsis. It made us all extremely careful, because we knew that everything we did was closely watched and no excuses would be accepted if a case went wrong; it would be the principle that would be blamed, and not the individual. By this time the antiseptic treatment had reached a stage where we felt that suppuration should not occur in an operation wound made through unbroken skin; if it did occur—and as we were not perfect, one or two cases would suppurate during the six months' session—we all felt it very much; we went about as if everything were lost, ashamed to raise our heads, and subjected to merciless chaff. Our only topic of conversation among ourselves on such occasions was how the infection had got in, what was the error in technique which had been committed, and whose fault it was. I do not hesitate to say that this holds true at the present time just as much as it did in the olden days.

By this time (1872 onwards) Lister's work had attracted more and more attention, and quite a number of surgeons began to visit Lister's wards. Curiously enough, very few British surgeons were to be seen, but other countries were well represented, especially Germany. Lister made a special point of showing all his methods and results to the visitors, and as there were constantly fresh arrivals he had to repeat his story frequently; thus his hospital visits were somewhat prolonged. In the early days to which I specially allude the steam spray had not yet been introduced, and it was very hard work to keep a hand spray going for any considerable time. The dressing of a patient followed a regular routine: the dresser on duty got on his knees at the side of the bed, and as soon as the bandages had been cut he started his hand spray; Lister then lifted off the outer dressing, which was solemnly handed round to each distinguished foreigner to smell. Having satisfied themselves that there was no putrefaction, the deeper piece of gauze which was generally placed over the region of the wound was passed round to show that there was no pus; in cases where it had not been possible to bring the edges of the wound completely together blood clot could be seen in places between the edges of the incision. In such cases Lister usually covered the wound with a piece of material called "protective," which was impermeable to carbolic acid; when this was exposed he would take a pair of forceps and peel it off, exposing the wound with the adherent organizing blood clot lying in the spaces where the edges had not come together, solid and firm, and with no sign of inflammation or suppuration in the wound. As a rule, this was followed by a sort of gasp of surprise by the distinguished foreigners, and then a violent conversation would break out among them, accompanied by equally violent gesticulations, so that one became alarmed lest the peace of the nations was going to be endangered. The poor dresser, who was almost, and indeed sometimes actually, faint from the pumping of the carbolic spray, was for the time being completely forgotten. But, however exhausted he was, and however much his wrist and arm ached, not one of his dressers would give in and let Lister down.

For some years Lister was probably most interested in revising the operative treatment of every disease or injury that presented itself from the point of view that he need not now fear sepsis in the operation wound. At first he did

more bone work than anything else—ununited fractures, badly united fractures, deformities of bone (he was the first to operate for knock-knee, very much on the lines of operation devised by Sir William Macewen some time later), wiring or pegging recent fractures—for example, fractures of the patella or olecranon—operations for varicose veins, open radical cure of hernia, extensive operations for cancer of the breast, and so on.

He was the first to resuscitate suprapubic lithotomy, though this is generally attributed to others. His remarks on this matter will be found in my notebook, where his reasons for this suggestion are given, but he was not very happy in their practical application.

He continued his efforts to find fresh antiseptics which might be less irritating and more useful than those he had hitherto employed, and reconsidered the treatment of all sorts of cases which came before him from the point of view of whether something better might not be done for them by operation than was being done at that time on the knowledge that sepsis might be reckoned to have now been entirely abolished from wounds made by the surgeon through unbroken skin. It was probably in that direction more than in any other that Lister's work became so intensely interesting to the students. They would come to his wards and see treatment employed which had apparently never been heard of or thought of by the other surgeons who did not employ antiseptic measures. It would be hopeless to attempt to give any sort of list of the new operations which Lister did, and he himself absolutely declined to publish them.

When I became more intimately associated with Lister I made repeated requests to be allowed to publish notes of his clinic, especially of the new operations and new lines of treatment which he was employing; but although he had done that sort of thing for Mr. Syme, he pointed out, quite correctly, that the matter was very different, and that if such procedures as opening joints, complicated operations on bones, and many others, were published, it might quite well happen that some surgeon who was not a believer in antiseptic treatment, or not sufficiently acquainted with the technique, might perform an operation on similar lines, and being without the protection of antiseptics the patient might quite well lose his life or limb as a consequence. That is the explanation why so little is known of Lister as a surgeon. But, as I said, I think that it was his fresh outlook on treatment, and the interest of speculating what fresh procedure Lister would suggest in a particular case, that fascinated the students most. The only sphere of operative work in which he did very little was abdominal surgery. Indeed, with the exception of ovariectomy, which was curiously enough supposed to be a very difficult operation and one sacred to a few specially gifted men, comparatively little work had been done in abdominal surgery as we now know it before Lister retired from practice, and he openly stated that he did not feel justified in embarking on surgery in a region with which he was not thoroughly familiar.

I became Lister's house-surgeon in Edinburgh in October, 1876, having spent nearly a year in Vienna and Strasbourg. I found the greatest enthusiasm over Lister and his work. Indeed, the fact that I had worked in his wards and was going to be his house-surgeon on my return to Scotland was a sort of open sesame, and one of the professors actually asked me to show him exactly how Lister dealt with his cases.

It was in the spring of 1877 that Lister accepted an invitation to go to London as professor of clinical surgery at King's College, conjointly with Mr. John Wood. The first that I heard of it was one Sunday morning, I think a day or two after he received the invitation, when I was sleeping quietly in the house-surgeon's bedroom. I woke up to find someone shaking me, and to my astonishment on opening my eyes I found that it was Lister. He told me about his invitation to London. He had not yet at all made up his mind about it, but if he went he would need to take a small staff with him familiar with his methods, and he had come down that morning to know whether, if he decided to go, I would go with him and again act as his house-surgeon for six months at King's College Hospital. Go

with Lister to London! I could not believe my ears. Of course, I would go with him to London or anywhere else. In addition he took Dr. John Stewart (now one of the leading surgeons in Canada and held in very great esteem there), Dr. W. H. Dobie of Chester, and Dr. Altham (who died soon afterwards) as clerks.

He arranged to begin his work there at the beginning of the winter session in October, 1877, and he was asked to give the address at the opening of the winter session. At that time he had become very interested in the question whether there were different "species" of bacteria, each with its own actions on fermentescible substances or in connexion with diseases. He had already been working with milk, and he decided to investigate the lactic fermentation of milk, which he did during the summer and autumn of 1877. He satisfied himself by many ingenious experiments that a small bacillus, to which he gave the name of *Bacillus lactis*, was the only cause of the lactic fermentation of milk, and its sole external function in the scheme of nature. The research was carried out with the precision and thoroughness which characterized all Lister's work.

He not unnaturally thought that the absolute demonstration of a specific bacterium, explaining much that was obscure at that time, would be of the highest interest to his audience. Large numbers of the leading surgeons in London and the provinces came to hear this lecture. Perhaps not unnaturally they expected to be told about the revolution in surgery which Lister had inaugurated, and instead they had to sit for an hour listening to details of a series of experiments which proved that the lactic fermentation of milk was due to a particular bacterium. The expressions on the faces of the audience were very interesting and rather amusing; the majority of the surgeons present could not understand what the lactic fermentation of milk had to do with surgery. Those were the days of the "practical surgeon," as opposed to the "scientific surgeon," the latter being supposed (why I cannot imagine) to have no practical skill or knowledge. It took a considerable time before the "practical surgeon" realized that his day was past.

When we arrived in London, as far as I can remember no one at King's College was doing anything specially in the direction of antiseptic work, and indeed only a very few surgeons in London. As regards Lister's lectures, the chief thing that struck us at once was the almost entire want of enthusiasm among the students as compared with Edinburgh; there was no crowd running to get a good seat. Apart from Lister's dressers, only a few students would stroll into the theatre quite casually, apparently taking little interest in the lecture and seldom taking any notes. After the enormous classes in Edinburgh and their great enthusiasm it was very disappointing and depressing. We found after a time that probably the main cause of this was that the examiners in surgery for the various diplomas and degrees were for the most part not favourable to Lister's views, and the students were therefore afraid to attend Lister's lectures in case they should by accident give his views to the examiner. A good many of them, however, planned to stay in town for some time after they qualified so as to see something of Lister's work. This state of matters continued for some time but gradually died away.

Lister was quite well received by the staff and the students, but the nursing department was very difficult to work with. The hospital was at that time nursed by a sisterhood who looked on the wards as their private rooms, into which no man should come without their permission, nor should he interfere with any of their arrangements, such as ventilation, etc. They could always produce a rule of their sisterhood why we should not do this or the other thing which we considered essential for the success of our work. Had we not possessed a keen sense of humour (being more or less of Scottish descent) I do not know how we could have got through, but most of the restrictions were so childish and so evidently invented on the spur of the moment that we could not but laugh at them. I believe the real trouble was that till we appeared on the scene the nurses dressed the wounds, but when Lister arrived he

naturally would not allow them to meddle with the dressings; this solution did not occur to me for some considerable time.

The staff, on the other hand, were quite cordial and interested. Not long after we arrived one of the surgeons was going to amputate a limb, and he asked me to come and look after the antiseptic arrangements. His technique was pretty defective, and he did not seem able to visualize the germs which were ready to seize every opportunity of getting into the wound, so I accidentally from time to time squeezed a quantity of carbolic lotion over his hands, for which I was, of course, very apologetic. He did everything that I suggested till it came to tying the vessels, for which he used silk and left the ends long. I begged him repeatedly to cut them short, and told him that they would never separate if the wound remained aseptic; but he was adamant—he had never seen a case where the ligature could not be pulled out after a few days. The wound healed by first intention except where the bunch of ligatures was, and no suppuration occurred. Day after day I dressed the case for him and he pulled the threads without success. Gradually he began to think that I had told him the truth, and ultimately I got him to pull the threads as far down as he could and cut them off as high up as possible. This he did, and fortunately, as I had taken special pains to keep everything aseptic, no infection took place, and that end of the wound was healed in a few days and no further trouble resulted.

At the time of the migration to London we were still using carbolic gauze, carbolic spray, and carbolic lotions, and although thymol, eucalyptus, and various other antiseptics were tried during the next four or five years, no real progress was made in this respect till after the publication of Koch's work on antiseptics. After that Lister took up various mercurial preparations, and a variety of gauzes impregnated with preparations of mercury were employed, which had all to be discarded after a time on account of irritation of the skin. Ultimately Lister examined a double cyanide of mercury and zinc, and this, being insoluble in water, was found to be unirritating. But it was effective as an agent to inhibit the development of bacteria, though possibly not to destroy them. It was soluble in the mixture of serum and blood which came from the wound in sufficient amount to render it an unfit soil for the growth of bacteria. This we have used ever since with quite satisfactory results, and I believe that it just fills up the loophole which is left where dressings which are simply sterilized but do not contain any antiseptic are employed. Where a large amount of discharge is expected I generally reinforce the cyanide dressing by a mass of salicylic wool placed outside it. As to these gauzes and wool, it must be remembered that though they contain antiseptics they must be sterilized in the autoclave also, because the antiseptics are not volatile, so that bacteria which may lodge in the dressing are not acted on by the antiseptic. The diluted lotions of mercury bichloride (1 in 2,000 and 1 in 4,000) were also largely substituted for carbolic acid; the carbolic spray had been given up in 1887.

Lister's active work in surgery came to an end about 1893. The death of Lady Lister in the spring of that year, followed soon after by his retirement from the hospital on account of the age limit, changed entirely the current of his life. But by that time general septic diseases had become practically unknown in his practice in so far as operations through unbroken skin were concerned, and suppuration, even of the mildest type, was an occurrence of extreme rarity, and the possibility of septic complications was quite negligible. He had also reached a point in his technique where the possible irritation caused by the antiseptics employed was not noticeable and did not interfere at all with the healing of the wounds.

In 1895 Lister was elected President of the Royal Society, and the work connected with that society gave him another five years of life. But after that, although honours continued to be showered on him, the great brain gradually became tired, his memory failed, and he began to long for the time to come when, as he firmly believed, he would meet his wife and his friends again and commence a new life.