Marcy (H. O.)

COMPLIMENTS OF THE AUTHOR.

The Scientific Rationale of Modern Wound Treatment.

BY

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OF BOSTON, MASS.

PRESIDENT OF THE AMERICAN MEDICAL ASSOCIATION; SURGEON TO THE HOSPITAL FOR WOMEN, CAMBRIDGE, ETC.

Read in the Section of Surgery and Anatomy, at the Forty-second Annual Meeting of the American Medical Association, held at Washington, D. C., May, 1891.

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THE SCIENTIFIC RATIONALE OF MODERN WOUND TREATMENT.

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The currents and counter-currents of surgical opinion, which dominate the methods of wound treatment, are perhaps nowhere better illustrated than at present in the public hospitals of London. In one of these the great founder of antiseptic surgery explains to his pupils and a very considerable number of surgeons, who gather daily in his wards from all parts of the world, the fundamental principles upon which his methods are formulated. These he exemplifies with painstaking care in the great variety of operations which are done in the amphitheatre of a large general hospital. It is noteworthy to observe that drainage is considered far less important than was earlier taught, although every wound is dressed with ample provision for protection from extraneous contamination, with the expectation that there may be, at least, a certain amount of serous or bloody fluid escaping from the

wound, which must be prevented from becoming infected. Mr. Lister now feels certain that the double cyanide gauze is by far the best protective dressing that has yet been devised.

In Guy Hospital carbolic spray may be seen in daily use, as a still further protection during the dressing of wounds, which is usually done at the bedside in the wards. In another hospital all this is openly abandoned, and antisepsis is not only considered useless, but harmful. Here, however, it is noteworthy to observe that the so-called system of cleanliness, which is emphasized, is antiseptic so far as it is possible to destroy the septic material with which, in life, all individuals are usually surrounded and must necessarily come in contact. This pertains especially to the field of operation, the operator, his assistants and the material used by them.

In Birmingham the surgeon, most often heard from, in unmeasured terms scouts all the processes pertaining to antiseptic surgery as "illogical and unscientific"; claims that even the vital tissues themselves in a state of health have ever present in them infective material, and that the dominating surgical thought of to-day is already an exploded fallacy, and that the system so elaborately constructed by Professor Lister is "as dead as Julius Cæsar."

In the great hospitals of Berlin there is a singular uniformity of both antiseptic and aseptic methods, revolutionizing all the work of the earlier days, both in technique and results.

In America, where opinion has its expression with the greatest degree of freedom, individuality is more noteworthy, and, although the teaching of surgery in the great centers of learning is largely based upon the fundamental principles as elaborated by Sir Joseph Lister, there is too often seen a carelessness of method, especially in detail, and corresponding imperfect result which indicates either a disbelief in, or an imperfect knowledge of what, for my own part, I had supposed long since considered demonstrated.

It is wise and ever profitable analytically to review, with critical care, our own convictions and experiences. This is not alone philosophic, but in large measure the way in which advancement may be made, and oftentimes leads to the condemnation and abandonment of our own most cherished ideas, resulting in the adoption of new means by which to reach a given end. Only by such measures can the individual himself become progressive, and keep apace with the tide of accumulated observations, with the assimilation of new truths, and himself become an important contributor to the advancement of science.

In this spirit, and not as a partisan, do I purpose to claim the attention of the Section to a brief discussion of the scientific rationâle of wound treatment, necessarily brief, although it were easier to write a volume than to attempt a correct presentation of the subject in the short time at my disposal.

So omnipresent is the appearance of vital activ-

ity in all organic material we cannot wonder that it long went unchallenged as an inherent factor. The ever illusive search for the beginnings of life led to the belief in a spontaneous generation, under favorable conditions, and to the solution of this problem we are first of all indebted, as the foundation of subsequent demonstration. Here Pasteur, Tyndall and many others of scarcely less note laid the foundations of a practical science, as wide-reaching as humanity, the importance of which hardly dawned upon their perception. In this connection it affords me the greatest pleasure to pay tribute to one of my earliest and most loved teachers, the late Prof. Jeffries Wyman, of Cambridge. In the *American Journal of Science and Arts*, vol. 34, July, 1862, Prof. Wyman gave an account of some experiments on the formation of infusoria in boiled solutions of organic matter, the result of which was that such solutions, exposed only to air which had passed through iron tubes, heated to redness, became the seat of infusorial life; the same results followed when similar solutions were enclosed in hermetically sealed flasks, and subsequently exposed to the action, for a short period, of boiling water. In a few instances, infusoria appeared when the temperature was raised above 212° F.

He says: "All living beings found under the above circumstances have been attributed either, 1st, to organisms, or the germs of them, supposed to be contained in the fluid experimented with,

or the air included in the flasks; or 2nd, to the direct transformation of organic matter into new living beings, independently of any germs, or living organisms whatever; or in other words, to 'spontaneous generation.' Abundant proof has been brought forward to show that the spores or germs of infusoria exist in the air in quantities amply sufficient to account for the presence of living organisms in solutions freely exposed." . . . "There can therefore be no certainty of the existence of spontaneous generation in a given solution, until it can be shown, that this has been freed of all living organisms which it contained at the beginning of the experiment, and kept free of all such from without during the progress of it. On the other hand, this kind of generation becomes probable, whenever it is made certain that infusoria do appear in solutions, in which the conditions just mentioned have been complied with."

For the purpose of determining whether infusoria can develop in organic fluids freed from living organisms which are kept secluded from atmospheric contact, Dr. Wyman entered into a long series of experiments with boiled solutions of organic matter in sealed flasks, which experiments were published in the *American Journal of Science and Arts*, September, 1867. The material used was an albuminoid product; usually boiled and filtered beef juice. The experiments were twenty in number and each usually consisted of a series of flasks, subject to a great variety

of exposures. The contents of the flasks were afterward carefully studied by himself and Prof. Henry J. Clarke, and the different varieties of bacteria were diagrammed, as seen under the microscope, enlarged from two to four thousand diameters. Prof. Wyman arrived at the conclusion, that at the temperature of boiling water, when continued for a sufficient period, the organic solutions contained in the flasks were completely sterilized, and that no matter what the surroundings or conditions, the fluid remained sterile until again brought into contact with the atmosphere. Under recent date, Dr. Morrill Wyman, of Cambridge, brother of the late Professor Jeffries Wyman, wrote me that some of the flasks used in these original experiments still remain with contents free from any evidence of life.

These original researches, by one of America's most distinguished investigators, are worthy of permanent record in the relation which they bear to antiseptic surgery. It seemed but a logical sequence that the introduction of these low forms of organic life into the albuminoid secretions of wounds would there germinate and be the legitimate cause of subsequent decomposition, producing all the train of evils incident to suppurating wounds.

Having once demonstrated that the cause of decomposition in organic fluids was due to an extraneous something, usually everywhere present, and that *that something* consisted of certain definite forms of life introduced into them from

without, these factors were plainly applicable to the treatment of wounds, and in this commenced the monumental labors of Mr. Lister.

The question, naturally, soon broadened out to determine, if possible, the varieties of bacteria which develop within the organism during the life of the higher animals, the peculiar conditions incident to their growth, and if certain varieties were more harmful than others. In other words, it became necessary to study *de novo* certain chapters of natural history, involving several families of the lowest orders of plant life. All this is now recognized as so important, that bacteriological researches, from the standpoint of laboratory investigations, are included in the curriculum of all the better equipped universities. These additions having been made to science, it naturally followed that, when the conditions of bacterial reproduction were known, it was then, and not *until then*, that the investigations of changed relationships which would limit, restrict, or prevent, their development could be intelligently undertoken.

Many of these investigations have borne fruitage of the greatest value to the human race. We now have the scientific demonstration of this in man, in the easy control of small-pox by vaccinia, established by the immortal Jenner; in the lower animals, in the valuable illustration of the same teaching by Pasteur in chicken cholera, and in the more recent and by far more important original investigations and demonstrations by

Dr. Frank Billings, of Nebraska, in the limitation and control of hog cholera and some of the diseases incident to the bovine race.

Very naturally this line of research has been extended, until it may be accepted as demonstrated that the large share of contagious and infectious diseases to which the human race is liable, are due to the introduction within the organism of a variety of spore plant growth, the development of which is the causative agent of the given disease. I need only to refer to the oft-repeated and generally accepted demonstrations of these important truths as illustrated in anthrax, cholera, tuberculosis, pneumonia, diphtheria, typhoid fever, measles, scarlet fever, etc.

Although quite a variety of other forms of growth may be introduced into the human system and germinate to the production of disease and death through the medium of an open wound, as for instance, anthrax, or diphtheria, it was speedily demonstrated that the poisoning of wounds was chiefly due to the micrococcal or round-celled growth. It was shown that these could be isolated, cultivated artificially, that they bred true, and upon reintroduction into wounds they always produced the same general class of symptoms and poisoning. Familiar illustration of this is found in erysipelas.

To show the fallacy that all organized material possesses in itself the means by which decomposition may go on spontaneously, a, so-to-speak, inherent bacterial infection of low order, the

early experimental observations of Prof. Wyman already alluded to, then demonstrated that the vital organisms contained in organic fluids were destroyed by the simple process of prolonged boiling, or by a retention for a considerable period at the heat point not above 212° F. A much more simple series of experiments unquestionably show that organic fluids, introduced into sterilized flasks without bacterial contamination, do not undergo decomposition, although freely exposed to atmospheric contact, provided that there is a protection of a slight packing of sterilized cotton which serves to filter out the germs of decomposition commonly present in the atmosphere. This is easily demonstrated in urine, or blood exposed to very considerable elevations of temperature, and these highly organized fluids remain sterile; unchanged indefinitely. The exposure of these same fluids to the atmosphere of a common living room, by the simple removal, for a few minutes, of the cotton protective, is sufficient to cause a rapid decomposition to ensue by the development of atmospheric germs coming in contact with them. This is shown to be a fundamental fact, pertaining not only to the fluids of the body, but equally also to the organized tissues, when treated in a manner that shall exclude from the same, the extraneous germs of decomposition.

In reply to an able and exhaustive argument by Professor James L. White, of Philadelphia, upon the present position of antiseptic surgery, Mr. Tait, of Birmingham, publishes in the *British*

Medical Journal, February 14, 1891, a defense of his position, from which I am constrained to make an extract, since Mr. Tait is so often quoted as an authority to prove the uselessness of what is called the antiseptic system of wound treatment: "Fortunately for my present purpose, Prof. White puts the issue syllogistically, and formulates for both of us a major premise upon the truth or error of which depends the whole conclusion; and I accept this issue freely. I say that germs of decomposition exist already in the blood and elsewhere in the body and are ever present, but do not bring about their results till death, or some condition which we may call a tendency to death, gives them permission so to do. Professor White says that the elaborate and carefully conducted experiments of Houser, Watson, Cheyne, and others completely contradict the statement 'which is really the foundation of Mr. Tait's argument.' In reply, I say I care not a straw for elaborate and carefully conducted experiments, no matter at whose hands, when their conclusions are diametrically opposed to every day experience." . . . "In truth the facts of the housekeeper and the henwife are far more scientific, that is, far more exact than those of our biological experimenters. They are in harmony with what I see in my work every day and therefore it seems to me a perfect waste of time to follow Professor White beyond his own major premise, which is utterly mistaken."

It may be accepted that the proof of the mis-

take in the major premise, as based upon such demonstrations, will not be received by the profession, as scientific, or determined, and to me it seems, in large measure, a waste of time to attempt to refute them. Really the housekeeper bases the entire art of preservation of all her organic compounds upon the demonstrations of Professor Wyman, already referred to. Upon these has developed the preservation of the food products, by the canning system in use in the various parts of the world. In America the meats of Texas, the fruits of California, the salmon of Alaska, are familiar illustrations of great economic commercial value in supplying our daily wants, giving employment to thousands of people and furnishing a product of an annual value of many millions of dollars.

We might broaden the inquiry to the natural decomposition of fruits and vegetables, including all the grains. Break the epidermal cells of the skin of the grape, the orange, pear, or apple, and all know the rotting of the fruits by the rapid development of a low order of new growths. All the starchy seeds, bulbs, and grains, are protected by an impermeable envelope during their so-called sound state. There is no vital force which holds in preservation these starch cells, they are simply stored up, like the albuminoid products of the egg, to serve as food in the development of the germinal cells in the earlier stages of reproduction, until the plant has reached a stage

of evolution with sufficient inherent power for an independent existence.

If I understand at all what is meant by the demonstration of the henwife, it is simply this and nothing more, that the vitalized ovum is surrounded by a mass of nutritive material, enclosed for its better protection in a porous casement of lime salts, which albuminoid material contained therein is utilized for the development of the growing chick and dominated by vital forces, which elements become parts of a vital organization in precisely the same manner as when the independent individual utilizes its food, which in later life is received into the organism through the alimentary canal. The chief difference that pertains in the characteristics of the growing organism, is that in the oviparous animals the nutriment necessary for the development of the ovum is emitted in a mass sufficient for the purposes of the economy of complete development, while in the mammalian vertebrates the fœtal nutrition, by the process of secretion and absorption, is elaborated pari-passu to meet the necessities of the individual development. In the one instance, the egg, when devitalized, speedily undergoes bacterial decomposition, introduced through the protecting envelope from without. In the other, as Mr. Tait should well know, the fœtus, having perished within the uterus, undergoes a process of maceration, but never decomposition, unless by the introduction of germs from without. Therefore, it is evident that Mr. Tait's major pre-

mise, as he understands it, based upon the scientific deductions of the housekeeper and henwife, are subject to revision, and indeed, when carefully studied, are strictly in accord with the scientific observations, as daily conducted in our better laboratories.

The problem confronting the surgeon is easily subdivided into the two chief factors viewed from the aspect of strict science. The first factor, based upon the accepted premise which I am sure few would have the hardihood to consider "illogical and unscientific," is that the vital organism with which surgery has to deal in itself, in health, is free from bacterial ferment, protected from without by a coat of mail, when unbroken impermeable to invasion, and from within through its mucous surfaces by a similar disposition of protective cells, is that all operative wounds made in such tissues should be, as far as possible, made and maintained aseptic; the second, when septic, to determine the best measures for the destruction of the infecting organisms. The wounds of the first class are liable to extraneous infection from everything with which they may come in contact, and hence the necessity for sterilizing the surroundings and the material applied. It is sufficient for our present purpose to omit reference to the manipulative detail, as to the means to be used to secure this end. I cannot myself doubt, but that the justly discarded and much abused carbolic spray, in the earlier stages of the problem, served as a valuable means in securing

good results. Irrigation proves a far better substitute and in the present state of our knowledge cannot safely be dispensed with. A wound in uninfected tissues should be aseptic, as far as possible freed from devitalized structures, carefully approximated, and held at rest. It should be maintained aseptic by the application of suitable dressings.

The second factor of the problem is a much more difficult one. How to treat a wound made in tissues which are already infected, or to best care for a wound which has by accident become the seat of septic ferment, is a subject upon which there is great difference of opinion. Anything like a satisfactory discussion of the problem confronting us demands the careful study of the varying conditions of the individual, the vital, resistant power of the infected organism, as well as the character and amount of the infection itself. The individualistic resistant force is a constantly fluctuating factor, naturally greater in young life and lessening in accordance with age, surroundings, habits, etc. Bacterial growth in dead tissue, under favorable conditions, goes on to the entire decomposition of the material.

When introduced into the living tissues in small quantity, although the heat point and albuminoid products for its food are ever present, the vital, resistant power of the organism may be such that the bacterial ferment will not germinate at all, or in such a limited degree that at the most the disturbing conditions are strictly lo-

cal and soon disappear. Under favorable circumstances, the resultant suffering and danger are in direct ratio to the amount of the infected material introduced into the organism, and this may be in such quantity as to entirely overcome the resistant power and rapidly cause its destruction. The character of the seed introduced also varies greatly, the reproducing power of some ferments, as anthrax, being such as no matter how small the quantity greatly to endanger the individual. Not seldom the prick of a needle, carrying a minute portion of bacterial infection from a dissection wound, may introduce a virus into certain localities, where its rapid reproduction produces speedy death, while many of the atmospheric germs, common to all localities, reproduce only feebly under the most favorable conditions and soon disappear.

In tracing out the processes which a healthy organism has at its command, it is of intense interest to note the manner in which Nature rallies her forces for resisting invasion. The profession have long been familiar with the rapid proliferation of cell character which goes on about a wound, and these changes have been more or less carefully studied from the beginnings of surgery. My earliest teacher in medicine, the late George A. Otis, Surgeon of the United States Army, whose monumental labors in the elaboration of the surgical history of the late War of the Rebellion won for him enduring fame, emphasized the observation that the so-called pyogenic membrane

n a bscesses was in reality protective to the surrounding parts and was not to be interfered with by surgical manipulation.

We now know that the leucocytes, so familiar to all versed in histological study, are endowed with a peculiar physiological power. One of the first processes which we are wont to observe under the name of inflammation, we find consists in a rapid proliferation of the white cells about the point of invasion, encapsuling, as it were, the foreign material. That they do more than this, having the power to surround and destroy, so to speak, under favorable conditions, to digest the bacteria is now generally well known, thanks to the observations of Metschnikoff. Although it is quite too early to draw general deductions from these facts and declare that the entire solution of the so-called vital, resisting power of the tissues lies in this power of the leucocytes, there is every reason to believe that this important discovery gives an explanation of satisfactory type to certain of the hitherto unexplained factors in the repair processes of wounds. In the repair of the minor subcutaneous injuries we have familiar illustrations of the part which the leucocytes play in the animal economy. The effused blood is surrounded by them, and the material of the exudate is appropriated for their own development. Minute capillary vessels are formed in the line of these invading cells and the process of clot disappearance and granulation tissue development go on pari-passu until the clot has

disappeared and new connective tissue restores the part to its former condition.

When a small colony of micrococcal cells have found lodgment, the leucocytes surround and shut in the enemy, until a wall of living granulation cells are formed, forcing it to surrender, and a localised abscess is the sum total of damage.

If we find in these familiar leucocytes, the so-called phagocytes of Metschnikoff, empowered to a certain extent with the ability actually to destroy infecting bacteria, we certainly have in a very considerable measure an explanation of the vital resisting power of the individual organism. If, under favorable circumstances, these canabalistic little workmen, not alone surround, but actually eat up, their enemies, we have the best of reasons for understanding why the comparatively few germs in the atmosphere of an healthy locality are far less dangerous to wounds than was earlier supposed.

Again we understand why in the so-called sugically clean wound, a wound where great care is taken to exclude foreign material, and the comparatively uninjured clean-cut surfaces are closely approximated, the reparative processes go on steadily, and rapid recovery supervenes, although in a strictly scientific sense, the wound may not be aseptic. The infected organism suffers in a two-fold manner. First, locally, that is, in the wounded surface and its immediate neighborhood, and in a general constitutional

poisoning. The latter is produced by a chemical substance capable of isolation, called sepsin. This may in itself be sufficient to cause death, and its importance can hardly be overestimated, but since it is the direct result of microörganic development, it follows that the control, or destruction, of the organic ferments is the sure way of cutting off the septic, systemic suffering.

In this process, the methods which have been emphasized as aseptic, or surgical cleanliness as in contra-distinction to antisepsis, bear no part except so far as they may aid in removing the products of decomposition. The prerequisite knowledge in this instance must be sufficient to enable the best trained surgeon to make use of those agents best fitted to destroy the organisms in loco with the least possible injury. Hence the wide field of research of a most painstaking and scientific character which must of necessity be traversed before a satisfactory solution of this question could be given. Now, we have the fruitage of a multitude of patient investigators; notably Mr. Lister and Mr. Cheyne, of England, Pasteur in France, Koch in Germany, Sternberg, Cabot and others in America. My own publications upon this subject were the fruitage of two years of carefully conducted laboratory experiments.

The mercuric-bichloride solutions are usually greatly to be preferred as more effective as a destroyer of infection and less irritant to the wounded surface. All pockets in suppurating

wounds must be carefully cleansed and drained, while in iodoform we fortunately have an agent, the crystals of which are only in a minor degree irritant, and as such absolutely non-poisonous. They dissolve very slowly and are germicidal only in solution. Hence by their use bacterial development is greatly retarded, if not altogether prevented. The iodoform crystals in most wound secretions, as ordinarily observed, dissolve so slowly that the antiseptic power is continued as a constant factor for hours, sometimes even for days together.

From this hasty, and necessarily imperfect, review of a subject second to none in interest or importance to our entire profession, we have omitted of necessity very much of value. However, I am certain that "the better methods of wound treatment have a fundamental basis of a strictly scientific character, the three important factors of which are: *First*, the vital resistant power of the individual. *Second*, the character and amount of the bacterial infection. *Third*, the local condition of the tissues at the seat of implantation.

The ideal treatment of wounds is certainly the restoration of the condition of the parts operated upon to, as nearly as possible, their primal state. If this can be effected aseptically, then there are no bacteria to be removed, and if the wound is surgically clean, with accurate coaptation of the sundered parts, then the vital forces are sufficient to utilize any resultant exudates, and drainage

is not alone superfluous, but harmful. The reparative process should go on under a dressing which will permit of the introduction of no foreign factorage. The various antiseptic dressings now so generally used, have a value in wounds necessarily drained, that is subject to a probable infection, but in aseptic wounds primarily closed, they are unnecessary, expensive and cumbersome."

For quite twenty years I have been in the constant practice of closing *aseptic* wounds by lines of buried animal sutures. Little by little I have been led to discard drainage, almost without exception, in this entire class of wounds, until I have formulated it as a rule of practice, that no matter how large or deep in non-infected structures, the sundered parts are rejoined, oftentimes by the use of several feet of tendon suture, and the wound is sealed by a germ-proof dressing of collodion. To this rule the larger amputations are no exception, and such wounds thus treated rapidly heal without pain or œdema of the coapted tissues. In reality, it makes little difference by what name we call this modern miracle of surgical wonder-working. It has its establishment upon the foundations of pure science; its future gives promise of still greater achievement, and we may look forward with confident expectancy to the day when medicine and science, although they cannot be exact sciences, will be understood and practiced with a scientific rationâle above contradiction or reproach.

My brethren of a noble profession, second not even to that of the clergy, may I not be pardoned a digression? We have spent the last two days in the Councils of the Academy of Medicine intent upon the purpose of elevating the profession to a higher standard of education, comparing the advantages of a general, with those of a technical training. May we not accept that they both should be broadened in the Catholicity of Science which is after all the demonstration of God's own law of pure and simple truth? The one profession reads it in the Divine revelation transmitted through the Fathers; the other in the unerring law of vital forces transmitted from the beginning of creation. The one teaches a mediatorial redemption from the transgressions of the moral law; the other knows of no high-road cast up for the escape from the penalties attached to the infraction of its inflexible government.

Since both emanate from a common source and center of Being, should they not be at least equally respected, investigated and obeyed? He who studies the infinitely minute, and yet sees through it all the marvelous working of a vital law, intended primarily for the beneficient good of the created, is moved by the same divine inspiration as he who measures the infinities of space and weighs the distant stars in the balances of mathematical correctness. If I read aright the future of our great Republic in the evolution of our race, the time is not far distant when the

necessity of sending our young men to the great centres of European thought for a higher development in the training and knowledge of the exact sciences will have passed.

Let our own Central Government not alone foster the education of the masses as a bulwark of defence in the protection of our own inherent safety, but let her also provide National Laboratories which shall amplify the advantages of the Carnegie and Johns Hopkins institutions for biological researches, the advantages of which to the well being of the entire race can hardly be overestimated.