MEDICAL LIBRARY AND HISTORICAL JOURNAL

Vol. 5 September, 1907 No. 3

A BRIEF HISTORY OF ANTISEPTIC SURGERY.

By Franklin C. Clark, A.M., M.D.,

Providence, R. I.

THREE notable events characterize the history of medicine, each of which in turn has completely revolutionized the practice of surgery. From remote antiquity to comparatively recent times three obstacles confronted the surgeon in the pursuit of his craft. One was the old-time, clumsy and unsatisfactory methods employed in arresting the flow of blood, especially the hemorrhage incident to operations; the second was the occurrence of pain which often rendered surgical interference a most formidable proceeding and even inadmissible; the third was the appearance of inflammation in wounds and its usual attendant, suppuration, to say nothing of capital operations all of which were followed by more or less danger to life or limb. It was to fulfill these several requirements for the successful treatment of surgical injuries that the efforts of the surgeon were attended so long with nothing but failure and disappointment.

Ambrose Paré, a French barber-surgeon, who flourished in the middle of the sixteenth century, is generally accredited with meeting the first requirement. He applied ligatures to the ends of divided arteries for the arrest of hemorrhage instead of resorting to the more common practice of using boiling oil or the actual cautery, whereby he saved the sufferer much pain and, at the same time, robbed amputations of a great part of their former terrors.[1]

[1]In this Ambrose Paré may have been anticipated for some fifteen centuries by the ancient chirurgeons who lived before the time of Celsus (100 A. D.). But ligatures, as we learn from this authority, were employed for the arrest of hemorrhages only as a last resort, or in conjunction with topical remedies. Here both ends of the bleeding vessel were ligated, and the intervening portion divided—a procedure adopted a century later

Nearly three centuries elapsed before the discovery of the anesthetic properties of certain substances, such as nitrous-oxide gas, chloroform and sulphuric ether, satisfied the second condition of the problem and marked another epoch in the history of medicine. And this discovery was the gift of the nineteenth century.[2]

The attainment of the third factor of the trinity followed the second in rapid succession and is known to us as Antiseptic Surgery. Though seemingly of sudden growth, the new surgical treatment has nevertheless been a slow and laborious development whose copestone was laid by Sir Joseph, now Lord, Lister in the latter part of the last century.

Thus, all three conditions necessary for the successful treatment of all open wounds have been amply and happily fulfilled. Bloodless, painless and non-suppurative, or antiseptic, surgery are now accomplished facts; while the dangers and sufferings, hitherto incident to all surgical operations, have been reduced to an infinitely low percentage. These three events, events perhaps unparalleled in the whole history of science, may be regarded as marking the three great epochs in the development of modern surgery, in that under one or the other falls the treatment of all traumatic injuries. A trial of some three centuries and a half has demonstrated the value of the first; the employment of over half a century has fully established the claims of the second; while the blessed boon, obtained through the last member of this surgical trinity, the youngest, the latest found, has amply proved, after an experience with it of some forty years, the possibility of healing every sort of open wound by first intention. The new treatment has before it a future which dares to be predicted and by means of which the art of surgery may well take its place in the domains of an exact science. And it is now

---

by two surgeons, Philagius and Antillus, for the radical cure of aneurism. But this practice seems to have fallen into desuetude, to be revived or rediscovered by Paré in 1564, whose reputation rests mainly, however, on his employment of ligatures in the larger amputations in lieu of the old, barbarous methods then in vogue. Gale, an English surgeon and a contemporary of Paré, is the only one who might dispute this honor with the French surgeon. But Gale's methods found no general favor, while those advocated by Paré were more original and satisfactory, and naturally won the day.

[2]Sir Humphrey Davy and Sir James Y. Simpson, David Wells and Thomas G. Morton, two Englishmen and two Americans, respectively, are associated with this discovery.

with this new mode of treating surgical diseases that it is our purpose to deal.

Now, however bright the future of this last accession to modern surgery may be; however wonderfully simple its method may seem, it was by no means of rapid growth; nor was it due to some sudden, spasmodic spurt of genius. No happy accident gave it birth; no single mind called it fully matured into existence. But, on the other hand, it was the consummation of a long and tedious and painful process of evolution, largely depending for its creation and development on a corresponding growth of the cognate sciences—the logical sequence of pure inductive reasoning, of laborious research and experiment. Lister was but the master-mind that gathered and joined the loose ends of the kindred sciences and made them one united whole whereby all subsequent uncertainty in the treatment of open wounds would vanish away forever by revealing the secret which had been wrested effectually from an unwilling Nature. The history of the growth and development of antiseptic surgery, therefore, is the history of the rise and evolution of the natural sciences, especially of chemistry and biology; the latter study having been made possible by the invention of the microscope.

But so vast is this field of inquiry, that a full discussion of the various steps which have led up to the establishment of antiseptic surgery would greatly overpass our prescribed limits. Accordingly, we shall confine ourselves to the presentation of the most salient points in each of the natural sciences which have contributed more particularly to that end.

The natural sciences, grouped in accordance with their practical bearings, may be considered as a creation of modern times. The renaissance, the reformation in religion, the liberation, as a natural sequence, of the human mind, the rise of the free cities and the rearrangement of governmental affairs on a more stable basis officiated at their birth. Before the occurrence of these events individual and material progress was all but impossible. A broad, ensanguined gulf, filled with the blood of the martyrs to their principles, formed the line of demarcation between the old civilization and the new. This once passed, progress was assured.

For more than fifteen centuries the physical sciences lay in abeyance. Hardly a ripple broke the surface of the intellectual torpidity. Here and there perhaps some adventurous spirit might disturb its murky depths, sailing, like some privateersman, under letters of marque, in the quest of the philosopher's stone or of the elixir of life. Now and then their furtive and futile endeavors to transmit the baser metals into gold would unwittingly add a new element or two to the meagre number of known elemental substances on which the future science of chemistry was to be built. But from the days of Empedocles, who flourished about 450 years before the present era, down to the last quarter of the eighteenth century of our own, what was known by the name of natural science, particularly chemistry, consisted of but a jumble of dissociated facts and observations; and this undigested knowledge was interpreted according to the superstition of the age.

The doctrine of the four elements ("earth," "air," "fire," and "water") constituted the sole dictum of the ancient philosophy which, under the signatures of "heat," "coldness," "dryness," and "moisture," was applied to the explanation of the various phenomena of disease. So long a time it required to shake the human mind from its profound lethargy. The intellectual light let in on free-thought by the liberation of the mind, was at first slow in permeating a period darkened for ages by accumulated superstitions. Once accustomed to its genial glow, there seemed but little of which the human was incapable.

Of the four elements above instanced none, according to the authority of antiquity, played so important and active a rôle in the production of disease as the air of the atmosphere. It was this air, as taught by Hippocrates, the Father of Medicine, and his school, that entered the different cavities of the body and provoked pain and every known malady. The gas, expelled from the stomach, according to the teaching of Hippocrates, was nothing more nor less than atmospheric air, the same air which we breathe, but now pent up in that organ and causing all the discomfort and distress complained of. The same air, when charged with miasm, might enter the system, poison it and give rise to many diseased conditions. Again, the gas, set free in the process of digestion or of fermentation in the stomach, was explained by the same authority as consisting of the same atmospheric air. Hence, if the air, when admitted into the interior of the body in undue quantity, were the prolific though not the sole cause of evil, it followed that to the same pernicious source might be ascribed the difficulty of healing *all open sores and wounds.* In the case of wounds, however, the evil effects of the air on them was considered to be due to its coldness alone.

Later observers and writers on medicine did but follow in the wake of their great master, darkening rather that elucidating the subject. Speculation was the order of the day; doctrines based upon preconceived ideas, without a leg to stand on. Neither the constitution of the air nor the immense numbers of microscopic forms of life pervading it was within their knowledge. For ages all observations were confined to the unaided eye and to fanciful deductions drawn from what was thus seen. Hence, the hostility of the air could only be attributed to some one of its physical properties, such as its heat, coldness, etc., all that comes only within the circumscribed senses.

From remote antiquity it was the settled conviction that the coldness of the atmospheric air was the true cause of the inflammation and suppuration of wounds—a notion which has survived to our own times However, an exception was made in that air might also be the vehicle of miasm as well as being itself inductive of disease. But no attempt was ever made to prove this assertion by actual experiment. It was simply a lucky guess which any one might have made. The age was one of theory and dogmatism: the words of a master offset any attempt to prove the truth or falsity of a theory.

The first observer to demonstrate some connection between air of the atmosphere and the putrefactive process and, hence, the baneful effects of air on open wounds, was undoubtedly Magnatus, who flourished in the early part of the sixteenth century of our era. As early as 1516 he advanced the view, that the air was charged with miasms which infected every part of the human system wherever they might find entrance. If a hole were made in the end of a new-laid egg, through which the air was permitted to enter, putrefaction of the contents of the egg he noticed was sure to follow. From this simple experiment he argued that the inflammation and suppuration seen in all open wounds was due to their *exposure to the open air;* and in his treatment of all such injuries he sought by various methods to prevent this contact. He did not specify any particular constituent of the atmosphere (then unknown) nor any one of its physical properties as the exciting cause of the evil, but thought the air was a carrier of poison. However, he was the first to establish a satisfactory, working theory, though unacquainted, for obvious reasons, with the whole truth.

A generation or two later, Ambrose Paré made a statement to the same purport, when speaking of the poisonous properties of the air of sick-rooms and camps. But beyond this bare statement there was nothing advanced further in this connection for centuries. Still the postulate adduced, that it was the atmospheric air which caused all the mischief in external wounds, became the recognized doctrine of the day; and from that time on it was the chief care of the surgeon to exclude the air from all such injuries as much as possible. To exclude the air was to hasten the process of healing. For it was a well-recognized fact, that, in the repair of simple fractures and in the healing of dislocations and of all wounds in which the surface remained unbroken —in short, in all cases where the atmospheric air did not communicate with the interior parts—all such injuries rapidly healed and apparently with little inconvenience and small risk to life. But in compound fractures and where the air had free access to an injury, inflammation and suppuration were almost sure to follow. Hence the reluctance of the older surgeons to make artificial openings into the tissues of cavities of the body. In order to secure a satisfactory result, the air must be excluded. It will be noted here, that the air as a disturbing element in the healing of wounds was regarded as a whole, not as a carrier or container of any morbific principle. But the fact could not be denied, that there was a true connection between the air and suppuration. And this became one of the certitudes of medical practice.

The next step was made, in 1783, by Benjamin Bell (1749-1806), an English surgeon of some note, who acted on the same line of reasoning. He was the first to draw attention to the evil effects of air when admitted into the interior of opened abscesses and proposed the use of drainage-tubes for evacuating their contents without permitting the ingress of air and causing the consequent putrefaction and, at the same time, expediting the cure. Delacroix (1790-1863), who was a French surgeon, in the early part of the next century improved on the methods of Bell by the invention of the aspirator, an instrument for removing the contents of abscesses, pleuritic and dropsical effusions, etc., without permitting the entrance of air during the operation. This, of course, proved a vast improvement over the old methods, entailing less danger to the patient and making the recovery more rapid.

The problem was assailed from another quarter, in 1794, by John Hunter (1728-1793), the celebrated Scotch surgeon. To him we owe especially the method of treating a certain class of traumatic injuries and deformities by what is known as *sub-*

cutaneous surgery. His philosophic mind seized at once the most salient points of the problem. He divided all wounds into two classes, the external and the subcutaneous. "The injuries done to sound parts," he observed, "I shall divide into two sorts, according as the effects of the accident. The first kind consists of those in which the injured parts do not communicate externally, as concussion of the whole body, or of particular parts, strains, bruises and simple fractures, which form a large division. The second consists of those which have an external communication, comprehending wounds of all kinds and compound fractures." He still further remarked that subcutaneous wounds seldom inflame; while open wounds both inflame and suppurate. In this way Hunter educed the principle (Tenotomy) on which every form of subcutaneous surgery was subsequently, though first, put in practice by the French surgeon, Delpeche (1775-1832). But, however this method may have been improved by later surgeons, the credit of first reasoning it out belongs to John Hunter.

On account of the irritating properties of the air (to use the language of the period), the healing of all open wounds by immediate union, or first intention (that is, union without the concomitant of inflammation and suppuration) was, except in trifling injuries, a rare occurrence. It was the *summum bonum* of surgery, the most desired and rarely attained end. Hunter considered that the healing of wounds under a scab, or, technically speaking, *by scabbing,* was the true and natural process. It was in this manner that nearly all the traumatic injuries in the lower animals healed; in fine, it was a matter of some difficulty to excite suppuration in the wounds of the warm-blooded animals, man only excepted. Few wounds in them occur that do not quickly scab over and heal readily. Exceptions do, however, occur in man even when extensive surfaces are injured, and close by first intention. Burns and scalds follow the same law.

Accordingly, to assist this process of scabbing in man, many mechanical appliances have been employed from time to time with varying degrees of success. For this purpose there have been used layers of cotton, dried blood, and in short, any substance which will cover the wounded surface and completely exclude the air. Collodion has also been employed for the same purpose and with excellent results. It was in his search for some satisfactory substitute for the natural process of scabbing that Lister was led to his discovery of the true principle of antiseptic surgery; for his earliest experiments in this direction were made by the use of carbolic acid, in conjunction with lint and blood, to form a coating over the injured surface in imitation of the natural scab. The lint was first saturated with the acid and blood and then applied. In order to prevent the evaporation of the acid, Lister fixed sheets of lead or of block-tin firmly over the application; under this artificial scab the healing process went on undisturbed. As will be seen further on, aseptic surgery was a consequent, an outgrowth of this artificial method of healing under a scab.

Thus far we have noted that the efforts of surgeons have been directed to the discovery of some means of excluding the air from open wounds, accusing, as they did, the air as a whole of being the sole cause of the disturbing influence. Even Lister, as we have remarked above, began his investigations with the notion that the main point in the treatment of wounds was to find some substance that would keep out the air. That the air contained morbific elements, capable of inducing inflammation and suppuration, was a problem which had not as yet been solved.

Up to this point surgery had accomplished all that it could do unaided; it needs must look to the natural sciences for further assistance. The discovery of the constituent parts of the atmospheric air formed another step in the solution of the problem. The chemists and physicists now enter the field of inquiry. The air around us was considered, from time immemorial, to be not a compound but a simple body. Down to the latter part of the eighteenth century, it was believed that the deleterious effects of the air on open wounds was due to some one of its sensible properties, its coldness for example. And, down to the time of Van Helmont, a German physician and alchemist who flourished in the latter part of the sixteenth century, this was the only gaseous body known to science. No addition to the common stock of knowledge on this point had been made since the age of Hippocrates, over twenty centuries before. But the time had now arrived when the long intellectual night was to be dispelled.

It was while Van Helmont was investigating the cause of the explosions of fire-damp in certain German mines, the nature of which was not then understood, that this early chemist, tinctured with the superstitions of the times, ascribed these accidents to the operation of ghosts, or spirits (German *Geists*).

Though thus, in a measure, conforming to the notions of the age, he clearly established the existence of a gaseous body apart from the atmospheric air, and enriched his own and the English vocabulary with the word Gas at the same time. This was the deadly ghost which, under the name of fire-damp, had haunted so long the cavity of the German mines.

A century now intervened without any further addition to the world's knowledge of gases. One fact, however, had been established beyond cavil: that another gaseous body existed besides the respirable air. But, in 1757, Black (1728-1790), a Scotch chemist, succeeded in separating from the atmosphere another gas which he denominated "fixed air." It was present in burning lime, or marble, and is known to us as carbonic-acid gas. One component part of the atmosphere was now discovered.

Less than twenty years later, Rutherford (1749-1819), a Scotch physician, Priestley (1733-1804), an English chemist, and Scheele (1742-1786), a Swedish chemist, succeeded in demonstrating the constituent parts of the atmospheric air nearly as we now understand them. And, in 1780, Lavoisier (1743-1794), a French chemist, completed the disruption of the chain, which had so long joined the ancient with the modern world, by the discovery of a new gaseous body in the atmosphere which he termed "dephlogistigated air," now known to us as oxygen. This gas constitutes the most important component part of the atmosphere. From its discovery by Lavoisier dates the birth of modern chemistry.

Now that the atmosphere was found to be composed of several gaseous bodies it became a still more fruitful source for the explanation of its deleterious effects upon open wounds. To which one of these gases were due these effects, if at all? That the air could contain any morbific elements never once entered the thoughts of observers at this time. The most eminent advocate of the air theory was Gay-Lussac (1778-1850), a French chemist. While investigating the subject of fermentation, he ventured the opinion that the phenomena observed here were due to the presence of oxygen in the air, and not to the air as a whole; thus opposing the then universally accepted doctrine. It may be here stated that, although not then proved, the two processes of fermentation and putrefaction were regarded as identical. Schwann (1810-1882), a German chemist, gave finality to this view, though his was a no bolder statement than the speculations of Willis (1659) and of Stahl (1697) nearly two centuries previously. But none of their views had been cast in the crucible of experiment.

The problem had now been narrowed down to one deleterious element in the atmosphere, namely, oxygen. And this was the teaching of all the medical schools down to the time of Lister, the accepted dictum of all surgical works. Oxygen now played the same rôle in surgical philosophy as once did the old exploded air-theory. However, it was but a surmise without any attempt being made either to prove or disprove it. Chemistry and speculation had reached their acme; the problem now enters the domain of physics.

Before the invention of the microscope, man had but a limited view of the natural world; what his unaided eye failed to discover was a matter of guess, of mere speculation. The attribution of some forms of disease to the miasms conveyed in the air was, as we have elsewhere remarked, a mere matter of conjecture. It now becomes necessary to retrace our steps to the point from which we started.

It has already been adduced how Hippocrates and later writers for centuries had arrived at the conclusion that the air had a deleterious effect upon open wounds. Of this fact they were certain, although with their limited knowledge of the natural world and without any mechanical contrivances to assist their narrow vision, they could advance no further. That the atmosphere around them contained immense multitudes of living organisms of exceeding minuteness never once entered the thoughts of the ancients. Yet housekeepers for centuries had made confections and preserved fruits in sugar without ever asking themselves the reason why such articles thus kept better than in their natural state. Canned goods in more modern times were introduced into the markets and retained their freshness so long as they remained unopened and the air did not find entrance. The contents of these cans had been subjected to long boiling, or cooking, before they were sealed up in the cans. In each case the only reason given for their preservation was, *that the air was excluded.* That there was *something* in the air, and not the air itself, which caused the fermentation or putrefaction, never once suggested itself to our good housewives. And yet, the theories then prevalent in regard to the cause of the suppuration of open wounds did not satisfy the mind of the great Hunter, who, though unable to corroborate his views by actual experiment, did not believe that it was the air alone that was the cause of fermentation and suppuration. And though at this time it was suspected that these two processes were one and the same, the fact had never been substantiated.

Let us then follow the suggestion of John Hunter and ascertain if the air contains any matters of a deleterious character. We have already shown that the constituents of the atmosphere had been discovered even in Hunter's lifetime, and that oxygen had been fixed on by surgeons as the disturbing element. Can the air contain anything else besides particles of dust; any living organisms? Such a question was impossible to answer before the invention of the microscope.

From the remotest antiquity down to the time of Harvey (1578-1657) it was the received opinion of the learned that many of the lower forms of life, whose metamorphoses were not understood, were produced from decaying substances in the presence of water. Under this head would be included maggots. "All bodies," says Aristotle, "which became damp, and all damp bodies which are dry, engender animal life." Thus was the origin of the lowest forms of life explained and the dogma of spontaneous generation first enunciated by the great philosopher whose dictum indisputably ruled the world for over twenty centuries.

As the history of fermentation and putrefaction (and hence of suppuration) is intimately connected with these low forms of life, it is now proper to enter more particularly upon their discussion. With the invention of the microscope the study of these vital organisms became possible. But little or nothing was accomplished before the time of Malpighi (1628-1694), an Italian anatomist, and Leuwenhoeck (1632-1723), a Dutch naturalist and the accredited inventor of the microscope. These two were the first to direct that instrument to the study of the blood, thus determining the constitution of that fluid and the movement of the red corpuscles in the capillaries. In 1672, the Dutch naturalist succeeded in demonstrating the presence in the atmosphere of a multitude of minute organisms, before unknown, which he denominated *Infusoria,* because they were first discovered in infusions. In 1680, he took the first step in the investigation of the subject of fermentation, making the well known yeast-plant (*Torula cervisiæ*) the subject of his experiments. But the rudely constructed microscope,[a] as it existed at that time, gave him but a rough outline of this interesting plant.

[a]The tube of some of the early microscopes was as much as twenty feet long—a very unwieldy and unsatisfactory instrument.

And it was not till a hundred and forty years afterwards, on the invention in France of the achromatic, refracting microscope, and particularly in 1839, when Mr. Joseph Lister, the father of the present Lord Lister of surgical fame, greatly improved this instrument, that any further progress was made in the study of vinous fermentation. And from this time date all the brilliant discoveries with the microscope which paved the way to the discovery of antiseptic surgery.

The first to take up the subject where the Dutch investigator left off, were Cagniard-Latour (1777-1859), a French naturalist, and Schwann, who is already familiar to us as a bold speculator. As was natural, they began their experiments with the yeast-plant and demonstrated its constitution and its mode of reproduction. They next passed to the study of other ferments, such as grape-juice, and found a similar condition of things to exist here. Latour regarded the minute bodies of which the yeast-plant is composed, but first made known by Leuwenhœck more than a century previously, as the cause of fermentation. Schwann not only confirmed Latour's conclusions here, but examined microscopically both animal and vegetable substances in a state of decomposition, thus proving beyond question the identity of vinous and putrefactive fermentation. According to this investigator, every kind of ferment was due to like causes; prolonged boiling would destroy all living organisms found present in both fermentation proper and in putrefaction; and if vials containing animal or vegetable substances should be thus treated, and after thoroughly boiling be hermetically sealed, no living organisms would reappear in solutions thus treated *unless the vials were opened and their contents exposed to the air,* when they would be quickly thronged with microscopic organisms.

The next step was taken by Helmholtz (1821-1894), a German, who was distinguished as a physicist as well as anatomist and physiologist, by whom the problem was narrowed to still smaller dimensions. He satisfactorily proved that *oxygen was not the cause of either vinous fermentation or putrefaction,* the accepted doctrine up to his time. For the exclusion of this gas from organized matters did not preclude the development of either of the two processes. It was thus conclusively demonstrated that the air was not at fault in either case. If it was not the air, what then was the cause?

In 1854, another Dutch observer, Schroeder Van derKolk

(1793-1862), entered the field and confirmed the conclusions of Helmholtz, showing that if infusions of meat-juice, malt or grape-juice were thoroughly boiled and the air filtered through cotton-wool before it was permitted to communicate with the infusions, neither fermentation nor putrefaction of such infusions would ensue. But it was left for Louis Pasteur (1822-1895), the great French chemist, to join the connecting links of this abstruse problem, when, in 1857, after a series of the most brilliant experiments, the most exhaustive and conclusive ever made, he established for all time the fact, that it was not the air as a whole nor any of its constituent parts which had such an unfavorable effect upon open wounds, but it was *certain foreign bodies contained in or conveyed by the air*—an innumerable multitude of living organisms, of such exceeding minuteness as to escape the ken of ordinary vision—it was to these microscopic forms, and to these alone, that were due the processes of fermentation and suppuration. To demonstrate this he used an ingenious arrangement of glass flasks and tubes which were partially filled with the infusions with which he experimented, which consisted of every known vegetable and animal substance. The infusions were subjected to prolonged boiling until all the organisms contained in the infusions had been destroyed, which fact was ascertained by no reappearance of such germs after cooling. This procedure, in scientific language, has been termed *sterilization, or Pasteurization,* after the name of the author. Bent tubes had been attached to the flasks, through which the vapor of the boiling infusions was allowed to pass. The infusions were then set aside in the flasks and permitted to cool. Air was thus allowed to pass and repass through the bent tubes and communicate with the boiled infusions at will. So long as the experiments were continued no reappearance of organisms was noted, no fermentation or putrefaction of the contents. It was supposed that these low forms of life were unable to travel up a bent tube unless aided by currents of air. Professor Lister had in his possession for many years a flask partly filled with urine which had been treated in this manner, and appearing as if it had but just been drawn.

In 1876, John Tyndall (1820-1893), the English physicist, varied the experiments of the great French chemist, which only confirmed the latter's conclusions. He smeared the inside of the bent tubes with glycerine which would catch and retain all germs floating in the atmosphere and in danger of being carried up the tubes by currents of air and communicating with the infusions. He ascertained also the fact, that, after the infusions were sterilized and before they were allowed to cool, if a piece of cotton was stuffed into the mouth of each flask, the contents would remain sweet for an indefinite period. The cotton-wool, according to his reasoning, filtered or sifted out the germs of which the atmosphere was full. And thus was proved beyond dispute, by these two eminent experimenters, that what had formerly been attributed to the atmosphere in the production of fermentation and putrefaction, was entirely due to these lowly forms of life.

Of course, down to this time, there had been numerous theories, more or less ingenious, to explain the process of fermentation. Among them was that advanced by Fabroni (1752-1822), an Italian chemist, more ingenious than demonstrable. He thought that fermentation was due to the decomposition of one substance with another. The theory, however, which became the prevailing one down to the time of Pasteur, was the oxygen-hypothesis, promulgated by Gay-Lussac, as already has been given.

But of the two theories of fermentation which now obtained the greatest prominence in scientific circles one was promulgated by Baron Liebig (1803-1873), the famous German chemist, in 1843, and the other by Pasteur, some ten years later. The first theory was known as the "mechanical" or "chemical" theory, or the theory of influence; that of Pasteur's, the physiological or germ theory, because it was based on the presence in decomposing animal and vegetable substances of microscopic forms of life termed germs, bacteria, microbes. These two rival hypotheses adduced for the explanation of fermentation and putrefaction soon dominated the scientific world, each with its powerful array of partisans.

The theory of Baron Liebig for a while seemed to carry all before it, if only from the great weight of his authority. According to this distinguished chemist, putrefaction and fermentation depended wholly for their formation upon a "ferment," as it was termed, which was composed of nitrogenous or albuminous substances of very unstable equilibrium in the presence of water. When a minute portion of this "ferment" was dropped into any organic solution, it would straightway produce the fermentation or putrefaction of the whole mass. The yeast-plant Liebig regarded as an exception to the rule, which he explained was due to an accidental formation and as had no connection whatever with the process of fermentation. However this theory might have been considered, it was defective in one and that the vital point: it was not the conclusion of actual observation and experiment. Its author never once thought of turning his microscope to the examination of these "unstable albuminoid principles"; nor did he attempt to give a reason for their origin. Neither in this theory could he honestly claim any originality; for he had been anticipated by Stahl by more than two centuries. Both could have tested their hypotheses by the use of the microscope, and Liebig to a more eminent degree. But both failed to do so and preferred speculation to ocular demonstration. It will be remembered that Stahl endeavored to reason out the identity of fermentation and putrefaction. The molecules of the fermenting body, according to the latter observer, occasioned all the disturbances which go by the name of fermentation; and these ferments were again originated in a pre-existing molecular motion. This ended the speculative age.

But before entering at large upon the masterly theory of Pasteur, it may be interesting to note what contributions were made to the subject by two or three investigators in the same line of research. In 1837, Latour directed his microscope to the study of the yeast-plant, as above noted, and showed the ability of its cells to reproduce themselves indefinitely. Schroeder and Schwann not only confirmed his observations but proved the fact, that if *infusions of organic substances be first sterilized before they are hermetically sealed, none of those minute organisms first found in such infusions will be reproduced so long as the air does not obtain admittance.*

It was in 1857 that Pasteur began his experiments on the subject of ferments which were destined to revolutionize the scientific world. But, unlike Baron Liebig, his distinguished rival, he never failed to subject every one of his conclusions to the slow and patient labor of confirmation. The microscope was to him the only sure and safe guide. He first repeated the experiments of his rival and showed by unimpeachable evidence that the so-called "albuminous bodies" of Liebig were not ferments at all but were the food of ferments—the true ferments being living, microscopic organisms. He furthermore discovered that every alteration in the quality of beer was coincident with the development of these minute forms of life which were entirely foreign to the nature of beer itself; and that the absence of such changes in beer and beer-wort coincided with the absence of the foreign bodies themselves. By elaborate and carefully conducted experiments, he demonstrated the intimate connection between germ-dust and fermentation and putrefaction; and, finally, *that it was not the air but the foreign bodies in the air, the germs,* that are the cause of all those injurious effects formerly ascribed to the action of the atmospheric air.

It is, perhaps, needless to mention here the ultimate triumph of Pasteur's theory, so fresh is it in every one's mind. Founded as it is on a series of experiments open to every one so disposed to repeat for himself and deny or confirm its truth, this theory must ever stand as a master-stroke in the history of natural science. It may well take its place beside the invention of the steam-engine or the printing-press.

Now, having established the fact that putrefactive fermentation as well as vinous fermentation is due to the presence of minute, invisible organisms which are constantly floating in the atmosphere in incalculable numbers and waiting for a favorable moment to take up their abode in putrescible substances and give rise to all those phenomena that were formerly ascribed to the agency of the atmosphere, we find a not unlike condition obtaining in all open wounds. For to exclude the air is to exclude these morbid germs and to assure a speedy closure of the wounds with rarely the usual accompaniments of inflammation and suppuration. Perhaps the exceptions may be occasioned by some imperfection in the treatment.

Now, though the relation of these bacteria to suppurating surfaces and putrescible matters was satisfactorily demonstrated, the origin of the germs was not so clear. The question now was, were they propagated from pre-existing germs or spontaneously produced? And, again, how far they might be active in the induction of disease? In answer to the first question a great controversy arose in regard to the possibility of spontaneous generation—a controversy that has been renewed again and again from the remotest antiquity and was now as ardently maintained respecting these lowly forms of life. The answer to the second query was the promulgation of the Germ Theory of disease for the explanation of contagious and infectious maladies—a subject which does not come within the scope of the present paper.

Down to the time of Redi (1626-1698), a Florentine naturalist, the spontaneous generation of the lowest forms of life as then known was an accepted fact, taught and received unquestioned with the same implicit belief as in the existence of witches. In 1668, Redi subjected this doctrine to a severe test which resulted in the overthrow of the prevailing opinion of the miraculous origin of maggots, which down to his time were believed to be of spontaneous origin. He proved that they were produced from flies alone, not from decaying meat.

The subject now remained quiescent till, in 1748, Needham (1713-1781), an English investigator who was particularly identified with the subject of spontaneous generation, took the popular side of the argument and attempted to prove that certain kinds of infusoria were generated in the dead and decaying matter of infusions. At the same time the powers of the microscope were called into requisition to draw the dividing line between the natural and the miraculous. Needham was followed by Spallanzani (1729-1799), an Italian anatomist, and by Schwann, already noticed in connection with the subject of fermentation, both of whom took the negative side of the controversy. And then, in 1838, Ehrenberg (1795-1876), a German naturalist, entered the arena and minutely described certain infusorial organisms which had once been claimed to be of spontaneous origin. But, despite all these experiments, the controversy was destined to continue, though common sense prevented the general acceptance of the theories of the advocates of spontaneous generation.[4]

But as the powers of the microscope became augmented and opened up a vaster field of minute forms of life, occupying a still lower scale of being than any which had yet been revealed, the problem of spontaneous generation became reduced to narrower and narrower limits. The true place in nature of these lowly organisms depended for their elucidation on the most careful manipulation of the microscope and on the greatest nicety of experimentation. The contest at this juncture waxed violent. Eminent authorities were arrayed upon both sides; it hung in doubt for the reason that it was difficult to determine the exact place in nature of

[4]Spallanzani affirmed that it was not the fermentation that produced the germs found present in the infusions, but that the germs which swarmed in the atmosphere in immense numbers caused the fermentation. Needham took the contrary view. Pouchet (1800-1872) was the great French exponent of the doctrine of spontaneous generation, which he advocated until his death. For an excellent discussion of this interesting subject see Larousse, *Grand Dict.*, article on "Generation Spontanée."

these microscopic organisms. However, the fact was beyond dispute that when the experiments had been conducted with the proper degree of care and accuracy, the opponents of spontaneous generation had the field all to themselves; every test in confirmation of their conclusions but established the same fact.

Now it would seem that Pasteur had, in 1858, settled once and for all the question of spontaneous generation, when he had conducted his experiments, already cited, in that direction. But at the time he must have unwittingly, in spite of all his care, left open some loophole to be used by his opponents. For this question was broached again by Henry C. Bastian, an English authority of considerable weight, whom it was left for Tyndall utterly to confute. Bastian was confident that the infusions with which he had experimented, even after the most extreme care had been taken to destroy the organisms contained in them, reappeared in some form within the hermetically sealed vial. He was certain that every precaution had been used to secure the success of his experiments.

Tyndall had not intended to enter the controversy, but was led to investigate this disputed question from an entirely different standpoint and from entirely disinterested motives. In fact, his line of study was in a far contrary direction. It was while he was investigating the properties of light that his attention was first called to the subject of spontaneous generation. While passing a beam of electric light through an ordinary room, he noticed an immense number of motes floating in the illuminated ray. On allowing the air of the room to remain for a time undisturbed, and then sending a beam of electric light again through the room, no motes became visible. Such bodies, whatsoever they are, escape the highest powers of the microscope. The circumscribing atmosphere is alive with them. These, he argued, constitute the origin of bacteria and reappear in sterilized infusions the moment such infusions are exposed to ordinary air.

Tyndall arrived at these conclusions only after repeated and carefully conducted experiments in which there could be no possibility of a mistake, and which any person might repeat for himself with the due exercise of the proper precautions. The apparatus which Tyndall used for this purpose was of the simplest character; more dependence was to be placed on the care to be exercised in conducting the experiments than on the elaborateness of the appliances. His sole apparatus was of domestic manufacture. It consisted of a square, wooden box, with two of its ends constructed of glass. In the rear end of it was a door; and the floor of the box was pierced with holes for the reception of test-tubes. The external air could communicate with the interior of the box only from the top, by means of two glass tubes, bent several times. A pipette, passing through a close-fitting rubber tube, smeared with glycerine and made perfectly tight, was used to fill the test-tubes when in place, with the infusions, so that the interior of the box had no communication with the external air except through the bent tubes. As another precautionary measure, the inside of the glass ends of the box was smeared with glycerine so that whatever motes might be floating in the interior of the box would be caught by it and retained. The test tubes employed in the experiment were made to fit the holes in the floor of the box with the greatest accuracy.

The apparatus was now allowed to stand undisturbed for some days, or until the motes which were floating about in the box had settled. A beam of electric light passed from time to time through the glass sides of the box would determine this fact. The test-tubes were then filled with both vegetable and animal infusions in the manner indicated above, which were heated from below by means of a spirit lamp and kept boiling until all life therein had become extinct. The air, however, during the whole time of this experiment was allowed to have *free access to the infusions through the bent tubes* that passed through the top of the box. The theory deduced from the experiment was, that the atmospheric germs were incapable of traveling up a bent tube. Finally, Professor Tyndall discovered that all sorts of infusions thus treated would remain free from any form of life for an indefinite period, and the solutions clear and undecomposed.

All these experiments of Tyndall were repeated by Pasteur, though somewhat modified, with similar results. It was thus demonstrated and confirmed by these two great scientists, respectively, that spontaneous generation had no existence. And since the dictum of these two men was final, the subject has never been reopened by any respectable observer. Spontaneous generation has now become a question of metaphysics.

Should we now be permitted to express in diagrammatic form the various steps in the evolution of antisepsis thus far enunciated, we should present some such a scheme as this:

FERMENTATION AND PUTREFACTION DUE TO THE ATMOSPHERIC AIR.

1. *To Physical Properties.*
   COLDNESS.
   (500 B. C.-1780 A. D.
2. *To Constituent Parts.*
   OXYGEN.
   (1780-1876 A. D.)

3. *To Foreign Elements.* (1836 A.D.)	*Inorganic Substances.* *Organic Substances.* GERMS (Conjecture,) (1680 A. D.)	*To Spontaneous Generation.* (500 B. C.= 1858 A. D.) *To Pre-existing Germs.* (1861 A. D.)

From a consideration of this table it is evident that all observers, from ancient times down, referred the processes of fermentation and putrefaction to the influence of the atmospheric air. So far as the unaided eye and a limited knowledge of the external world could detect, all had been accomplished that was possible. With the invention of the microscope and the divorce of chemistry from alchemy, more accurate knowledge was obtained in regard to the natural phenomena. The dates which have been given in the above scheme are merely approximate; they are intended only to denote the particular time at which any new discovery was made. Ten-year periods would, perhaps, have expressed the time of such discovery or change of opinion more correctly. One period necessarily overlaps another; and one or two dates can be fixed exactly so far as the year is concerned. But one thing, however, is clear, that we may trace each step of the evolutionary process that culminated in the discovery of the cause of a great variety of maladies which will, if not immediately, be ultimately prevented or actually cured in a medical point of view. The result of this knowledge was the establishment, as we all know, of antiseptic surgery on a firm and lasting basis; the surgeon is no longer obliged to work in the dark.

It now remains to collect these scattered threads and weave them into some connected whole. The ground has been prepared for gathering the fruits of these many years of the most patient and laborious experiment. It will be remembered that it was his search after some substitute for the natural process of scabbing which first led Lister to make use, among other things, of carbolic acid for this purpose. In this he was as successful as by any of the other methods. This procedure he did not follow from any previous knowledge of the antiseptic qualities of this acid. The principle of antisepsis had been already discovered; and the remaining factor in the problem was to find some antiseptic to secure that end. This Lister accomplished and thereby acquired his immortal fame. He adopted the discoveries of the age and practically applied them for the first time to certain ends.

Fermentation and putrefaction being cognate processes, the inflammatory changes taking place in all open wounds would fall under the same law. To destroy the germs in fermentation was to destroy similar disturbing elements in suppurating surfaces; and again to prevent the air, which is laden with these minute forms of life, from coming in contact with such open wounds was to preclude inflammation and suppuration in them. First, then, we are to seek for some remedy to destroy such organisms as have already found entrance into the injured parts before or after the inflammatory process has begun; and lastly, to prevent all further entrance of the germ-laden air. Such is antisepsis. But it must be remembered that these morbid germs and bacteria generally constitute the factors of decomposition in both animal and vegetable tissue. All dead and decaying substances abound in them; they are the active agents in reducing higher organized beings to their original elements. It is only those which are injurious to man or man's welfare that can be classed among diseased germs.

It was in 1867, the epoch-making date in the history of surgery, that Sir Joseph Lister, then Mr. Lister, first published his procedure in the treatment of open wounds by the new or "antiseptic method." The word "antiseptic" itself had been but recently coined. Everything about the subject was then new in spite of the great amount of scientific material already known to the world; but it was unclassified, ungeneralized, inchoate.

For some time previously, Lister had been studying that most important but most exasperating subject of suppuration in order to find some reason for the deleterious action of the atmosphere on open wounds—a generally accepted fact. In this connection the Scotch surgeon remarks, as to "how the atmosphere produces decomposition of organic substances, we find a flood of light has been thrown upon this most important subject by the philosophical researches of M. Pasteur, who has demonstrated by thoroughly convincing evidence that it is not to its oxygen or to any of its gaseous constituents that the air owes this property, but to minute particles suspended in it, which are the germs of various low forms of life, long since revealed by the microscope and regarded as merely accidental concomitants of putrescence, but now shown by Pasteur to be its essential cause, rendering the complex organic compounds into substances of simple chemical constitution, just as the yeast-plant converts sugar into alcohol."[5]

This quotation must make it patent to all that Professor Lister at the outset of his researches adopted the germ theory, adduced by Pasteur, in his explanation of the phenomena of fermentation and putrefaction in preference to that by Liebig. He thus continues: "A beautiful illustration of the doctrine seems to me to be presented in surgery by pneumothorax with emphysema, resulting from puncture of the lung by a fractured rib. Here, though atmospheric air is perpetually introduced into the pleura in great abundance, no inflammatory disturbance supervenes; whereas an external wound penetrating the chest, if it remains open, infallibly causes dangerous suppurative pleurisy. In this latter case the blood and serum poured out into the pleural cavity, as an immediate consequence of the injury, are decomposed by the germs which enter with the air, and there operate as a powerful irritant upon the serous membrane. But in case of puncture of the lung without external wound, the atmospheric gases are filtered of the causes of decomposition before they enter the pleura, by passing through the bronchial tubes, which, by their small size, their tortuous course, their mucous secretion and ciliated epithelial lining, seem to be specially designed to arrest all solid particles in the air inhaled. Consequently the effused liquids retain their original characters unimpaired, and are speedily absorbed by the unirritated pleura."[6]

Agreeably to the principles which he had thus most per-

---

[5]*Lancet*, Lond., 1867, i, pp. 326 *et seq.*
[6]*Loc. cit.*

spicaciously laid down, Professor Lister first directed his attention to the treatment of compound fractures by this new and original procedure. It was in 1864, three years previously, that he had his attention called to the remarkable effects produced by crude carbolic acid in the sewage of the town of Carlisle, a place of considerable importance in England, near the northern border. The refuse matters of the neighborhood had been thrown upon the open fields for fertilizing purposes. In the same pastures cattle were allowed to graze. But before these matters were spread over the meadows, Professor Lister noticed, they were mixed with crude carbolic acid which had the effect of deodorizing the sewage and at the same time of destroying any deleterious substances contained in it; for he learned that all the cattle accustomed to be pastured on these fields before the sewage had been thus treated, had been subject to a certain form of entozoa, but, after the use of the acid, they remained unaffected. Professor Lister was at once sensible that carbolic acid was a powerful disinfectant and capable of destroying low forms of parasites which had formerly affected these cattle. In short it was what we in our days would call a powerful antiseptic.

In March of the following year, Lister first put in practice his new method of treating open wounds. He began at the Glasgow Royal Infirmary, with which he was connected, with compound fractures, which he dressed with cloths dipped in a strong solution of carbolic acid and water. Though his first case did not meet his anticipations, he was not discouraged, but continued the practice all the more carefully, when at last, he was able to change compound to simple fractures *without the usual concomitant suppuration.* For two years longer, assisted by his colleagues at the hospital, he continued his experiments and had the satisfaction of proving the certainty of the treatment of this form of fracture by the new method, which not only obviated all danger from any subsequent suppuration, but hastened the cure.

In 1867 he extended to abscesses this form of treatment, to which, for the first time, he gives the name of the "Antiseptic Treatment." In this class of cases it was his aim to let out the contents of abscesses without the admission of air. He first prepared a twenty-five per cent. solution of carbolic acid and boiled linseed oil. The abscess was then opened with a bistoury, whose blade had first been dipped in this carbolized oil. Next, a piece of cloth, which had also been saturated with the mixture, was laid over the opening made with the bistoury, and the contents of the abscess squeezed out beneath the cloth. Lastly, restraining whatever hemorrhage resulted, by thrusting through the slit a pledget of lint, also saturated in the antiseptic, the wound was then dressed in a similar manner. This was the sole dressing which he ever employed in such cases during the whole treatment. The abscesses rapidly healed without any further secretion of pus. But in all these cases, curiously enough, he but imitated the natural process of scabbing. However, in the case of abscesses, he permitted the carbolized oil to penetrate into the wound. He had not as yet fully comprehended the significance of the action of the carbolic acid.

The same mode of procedure was followed in the case of incised, punctured, lacerated, and contused wounds with the most happy results. Finally amputations and all the different branches of operative surgery came in for their share of the new treatment resulting in a success that was never before equalled.

Thus far his efforts in some degree had been to imitate the natural process of scabbing, though it must be admitted, with some notion of antisepsis. Professor Paget, another distinguished contemporary, says he did this for the purpose of "arresting the causes which, in man, too generally spoil the natural process. The covering of a wound, as in a compound fracture, with materials soaked in a solution of carbolic acid, excludes all the external air, or at least those organic materials in it that would be injurious. Thus the wound is rendered practically air tight, and may heal without suppuration, simply scabbing over." But Professor Lister's method of healing open wounds, as thus explained by Professor Paget, soon ceased to be an imitative process when the conditions which led to the formation of pus were satisfactorily understood.

The object which Lister now had in view was twofold; it was not only necessary to keep the morbific organisms in the air from coming in contact with the wound, but also to destroy those which had already found entrance. This constitutes the last step in the evolution of antiseptic surgery, namely, to render all wounds *aseptic* as well as *antiseptic*. This is secured by sterilizing, or aseptizing (the proper word) all instruments and appliances used in dressing wounds, in performing operations, and in rendering all such injuries aseptic by the use of some agent to destroy the germs lurking in the wound. Lastly, antiseptic dressings complete the treatment.

At the beginning, it was thought that carbolic acid, when used in its full strength or too freely, would injure the sound tissues in the vicinity of the wound. This, as we know, was the first antiseptic used; and in the early history of its use for this purpose, we may occasionally note cases of poisoning by this acid. But as it became better understood, the dangers from carbolic acid rapidly diminished. Other antiseptics were discovered in rapid succession; while this acid itself was found by experience to secure all the desired results when used in a much diluted form; from a five to a ten per cent. solution and less being the usual strength employed. Even this small percentage largely diluted with water, when used as an antiseptic wash, answers well all the requirements of an antiseptic.

Now that the controversies arising from the new method of treating surgical injuries have long ceased to concern us, and the principles of antiseptic surgery have been fully established, we are the more prepared to fix its place among the great discoveries of any age. This boon, together with that of anæsthesia, or painless surgery, must be regarded as two of the greatest events that ever occurred, to be placed side by side with the discovery of a new world or the invention of the steam engine. Rarely has it been the lot of one man thus to benefit his fellows by wresting from an unwilling Nature a secret which has perplexed the greatest minds of all ages. "Any statements on any subject," says Cheyne, in his work on Antiseptic Surgery, "to be of value in the development of that subject, must be founded on knowledge and rigid application of the facts of nature, whether or no those facts seemed at first probable and sufficient explanation of the phenomena. That advance can only be blind and imperfect till the true law of nature is discovered, is well illustrated by the history of the wound treatment of former years. Through the darkness which then reigned, glimmers of light at times penetrated; but no true and lasting progress was made till quite recently, when chiefly by the scientific labors of two men—Pasteur and Lister—a flood of light has been thrown on one of the most obscure subjects in nature, and the foundation of rational treatment on rational and scientific principles has been followed by inestimable advantages to mankind."

A brief restatement of the antiseptic theory or method may not be out of place, though it may seem almost a commonplace to the present generation. Vinous and putrefactive fermentation being regarded as the exhibition of the same phenomenon under varying conditions and due therefore to like causes, it follows, that what form of prevention will apply to one, will of necessity apply to the other. In every instance of that condition of things which we term putrefaction, there are always present in greater or fewer numbers certain minute organisms termed microbes, bacteria, or germs. The metamorphoses, or organic changes, which these low forms of life undergo among themselves, give rise to all the phenomena observed in fermentation and in all kinds of decomposition, formerly attributed to some mysterious influence of the atmospheric air, if not to spontaneous generation. To destroy or to keep these germs from having access to putrescible or fermentative matter, constitutes the sum and substance of antisepsis; the application of this principle to the treatment of open wounds, antiseptic surgery. A familiar example, already given, is that of canned goods. The microscopic germs, or bacteria, infesting the foods to be canned, are first destroyed by prolonged boiling in their receptacles. A small hole is left in the top of each can, after being soldered on, for the steam to pass out. When the boiling has been completed, this aperture is then closed up with solder. The bacteria have now been entirely destroyed without the possibility of any more entering, unless the can is reopened. If open wounds can be treated on similar principles no inflammation or suppuration results. This is exactly what our antiseptics do. They destroy those germs already present in the wound and keep all others from coming in contact with it till healed.

The word, "sterilize," is usually applied to the operation of cleansing wounds, instruments, etc., as well as in the preparation of solutions and liquids for making cultures and experiments in bacteriology; and from that we form the derivative known as "sterilization." A much better term for one or two of its uses, in my opinion, would be some derivative of the words "aseptis" and "antiseptis." Thus, to render any wound or surgical instrument and appliance aseptic, we might use with all propriety, the word "aseptize;" and so with "antiseptize," for the same reason. Both words are founded on sound philological principles. Thus three distinct principles might be expressed each by a distinct word for which one term now does treble duty.

It would be a wearisome task to enumerate half the agents which have been offered to the profession as possessing antiseptic or germicide properties, whose name is legion and number never lessening. Of them all, carbolic acid (or phénol, as it begins to be called by purists) still takes the precedence. The halo of honor which hangs over it for being the first medium by which the antiseptic problem was solved, will never allow its place to be usurped by newer products. Although its peculiar odor is somewhat an objection to the fastidious, yet it has no superior, few equals. Iodoform, and its substitute, aristol, though much employed, is far more disagreeable than carbolic acid, without possessing any advantage over it. For a dry dressing acetanilid is far preferable than either of the two last; it is both aseptic and antiseptic, clean, inodorous, and comparatively innoxious if used with discretion, and especially valuable in the treatment of ulcerated and suppurating surfaces. Corrosive sublimate, in weak solutions, has also been highly extolled; but on account of its intensely poisonous nature, there is some danger in its employment, even in extremely weak solutions when used in large quantities. The stearoptenes, such as thymol and eucalyptol, both vegetable products, have been much esteemed, especially for mouth-washes and applications to the mucous surfaces generally. Thymol, however, is not so good in the treatment of open wounds on account of the attraction its balmy fragrance has for flies. Peroxide of hydrogen is another valuable antiseptic that is coming into greater prominence every day, and it bids fair to rival carbolic acid in popularity. It enjoys immense advantages over almost every other. Inodorous, almost absolutely harmless in any quantity (though a weak solution is as effective in most cases as a stronger one), it is, I was going to say, the ideal antiseptic, did not my loyalty to carbolic acid forbid me uttering such heresy. For ulcerated and suppurating surfaces it has no superior. Boric, or boracic, acid also enjoys considerable popularity.

Now whatsoever antiseptic be chosen, or whatever method of dressing wounds be adopted, in no instance, for the intelligent attention to all open wounds as well as in operative surgery, should the principle on which asepsis and antisepsis depend, ever be lost sight of. The blessed boon which Lister has bestowed upon suffering humanity, would be but little appreciated, its lessons unlearned, did we not fully comprehend the grand principle on which the new method is based. The skilful surgeon will choose that antiseptic which will best meet the case in hand.

Besides this selection of the proper antiseptic, there are other matters which, though of minor consideration, are of no less importance in the successful management of surgical cases, especially in operations. All the instruments used should not only be clean, but surgically clean; in short, they must be *sterilized,* to speak in surgical parlance, or *aseptized* more properly. All danger of introducting morbid germs into open wounds must be avoided. Hence the hands and instruments of the operator must be treated with some form of antiseptic before the operation begins. Nurses and assistants must take like precautions; the wounds themselves, or the parts to be operated on, be aseptized. If the operation is performed in a private residence, all unnecessary furniture should be removed from the room.

The new surgery has called forth a new class of appliances and instruments, dressings as well as antiseptics, too numerous to mention. The old-time ivory-, bone-, and wooden-handled instruments are now discarded for those made wholly of steel, so as to prevent any danger from prisoned germs. The most approved aseptic here is boiling water, in which the instruments may be immersed before and after operations. Other instruments may be treated by some approved antiseptic. But success in the new treatment depends upon three essentials: knowledge of the principle of antisepsis; absolute cleanliness, and simplicity. On these three hang "all the law and the prophets."