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Croonian Lectures

OR

THE NUMERICAL METHOD, AND ITS APPLICATION TO THE SCIENCE AND ART OF MEDICINE.

DELIVERED AT THE ROYAL COLLEGE OF PHYSICIANS, 1860.

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PART II.

The Science of Medicine and the Art of Healing the most difficult of all the Sciences and Arts. Human Beings, the Objects of our Study, differ widely from each other. Causes of that difference in Health and in Disease. Summary of the Causes which render the Science of Medicine and the Art of Healing so difficult and uncertain. These Difficulties and Uncertainties in no way dependent on our Ignorance of the Nature of the Vital Principle. Necessity of Improved Logical Methods. The Numerical Method. Definition. Valuable Properties of Figures, as substituted for Words of Uncertain Meaning. Simple Units, and Units of Variable Magnitude, the ultimate expressions of the combined operation of many forces.

HAVING treated of the leading sciences and scientific arts, and shown that the degree of perfection they have attained is mainly dependent on the extent to which they admit of the application of figures; having made some necessary distinctions between the "relations" and the "properties" of matter, and having also passed in review the sciences and arts of agriculture and of government, as affording some clue to the causes of the difficulties and uncertainties of our own science and art, I now proceed to speak of the science of medicine and the art of healing.

If the science and art of the agriculturist are difficult because the subjects of his study and practice are endowed with life; if the science and art of government are difficult because of the infinite variety of human character, interests, and passions, so (but to a much greater degree) are the science and art of medicine difficult. We too, as scientific and practical physicians, have to do with a living being; but it is with a being of far more complex structure and function than plants or even than other animals; and we, too, have to take account of the effects produced by the same mental and moral causes which perplex the statesman. The object of our study and practice is a compound and complex one. It is a being consisting of a vast assemblage of parts and organs of most curious workmanship, of most delicate mechanism, all working together to one end, life, thought, and action, every part traversed by vessels and nerves, every principal organ acting in harmony and sympathy with every other; the mind affecting the body, the body reacting on the mind; the whole constituting a being as wonderful in its intricacy as is the collective material world which he inhabits; so that he is familiarly and not inaptly termed a *microcosm*, or *little world*.

A closer and more minute examination of this object of our study by no means impairs or weakens the first impression which it makes upon us. The sense of difficulty and perplexity grows as we pass from the individual to the species. If every human being were equally perfect in form and constitution with every other, the study of such a being, in health and in disease, would transcend all other studies in difficulty.

But we all know that there are no two human beings in the whole world alike in all respects. Sex and age themselves occasion remarkable differences, with which we must be acquainted, and for which we must make allowance. But even two human beings of the same sex and age may differ, in an extraordinary manner, from each other. They have been born into the world with their own peculiarities of form, and structure, and function, inheriting the physical and mental peculiarities and defects of remote ancestors. And these two beings, of the same sex and age, may not only have been brought into the world with these differences, but before they fall under our observation as suffering from a disease bearing the same name, may have been brought under the most opposite influences, physical and moral. The one shall have been reared in the lap of luxury, the other in poverty and privation; the one shall never have been obliged to make one painful effort for his own support, the other shall have known but one unceasing round of monotonous labour; the one shall have been in the constant enjoyment of pure air, and wholesome nourishment, and invigorating exercises, the other pent up in the close and fetid atmosphere of the most unhealthy city; the one shall have adopted, by wise choice, or through the happy influence of good training and good example, habits of temperance, order, and chastity, the other have fallen, through his own perverseness, or from ignorance, and the want of good education and good example, into the lowest depths of intemperance and profligacy. But in addition to that permanent state of frame which is brought about by the prolonged operation of these causes, we have to take into account, as causing one man to differ from another, those more transient departures from health which are brought about by such causes as fatigue, sleeplessness, want of food, and anxiety of mind.

Thus, then, it happens that the human being whom the physician has to study and to treat is not only a most *complicated* and *compound* object, but one which differs in many important particulars from all his fellows. I need not say that if he thus differs from his fellows before he becomes the subject of disease, he will, when in a state of disease, differ at least as sensibly. His malady, though bearing the same name, will not be exactly the same thing. It will have its own peculiarities of extent, of degree, of duration; will be more or less amenable to treatment, and, if it prove fatal, will leave behind it its own amount of structural change, and its own peculiar morbid combinations.

The same observations that apply to the assemblage of symptoms which constitute a disease, apply equally to any one single symptom. Take as an example that simple and easily observed and described symptom, the pulse. We all know that no two pulses, even of persons of the same sex and age, are exactly the same in number and character; and that all the general rules which have been established in respect of this function are liable to several very curious exceptions.

Again, if we limit our observation to the grand results of disease and of its treatment (I mean death, or recovery, complete or partial) we encounter an almost infinite variety; for while there are some diseases, such as hydrophobia, which have hitherto proved uniformly fatal, and others which always terminate in recovery, there are to be found between these two extremes every possible variety in degree of fatality, and a considerable class of maladies (I mean epidemic and contagious diseases) which have a special rate of mortality at each outbreak, in each locality, and in each portion of their career, from their commencement to their decline.

Another source of difference between one patient and another suffering from the same disease, is their different mental constitution, and different mental states. The one naturally sanguine, the other naturally desponding; the one prone to place confidence in others, the other as prone to distrust; the one free from anxiety for the future, the other harassed by real causes of disquietude, or by fancies equally injurious.

One other source of difficulty and perplexity is too obvious to have escaped your notice. I mean the different degree in

which patients labouring under the same malady observe the rules laid down for their guidance, and submit themselves to their medical attendant; and the widely different amount of care and skill with which they are watched and nursed. The greater or less promptitude with which the patients, or their friends, apply for advice, is another cause of difficulty belonging to the same class. Nor ought I to omit from the list of causes of difficulty almost peculiar to our profession, the variable properties and equally variable degrees of purity and strength of the remedies in use. This remark applies not only to drugs, but to the remedial agency of climate and change of air; for at the time of sending a patient to a particular spot selected as suitable to his case, the characteristics of the climate may be wholly changed by exceptional conditions belonging to the year or season.

I should grow tedious were I to enter more minutely (as I might very easily do) into the causes which make one object of our study and practice (one sick man) to differ from another labouring under a disease bearing the same name. I have said quite enough for the object I had in view, which was to represent the studies and practical duties of the physician, as beyond all comparison the most difficult and perplexing that can engage the attention of a professional man; and, on that very account, as standing in need of the very best aids which it is possible to provide, in the shape of sound logical methods of collecting, arranging, classifying, and analysing facts.

I shall presently enter at some length into these methods, which in the aggregate make up the logic of sciences of observation; but I shall first ask your attention to a short recapitulation of the leading considerations which I have already brought forward.

Assuming as facts, not admitting of dispute, the existing imperfection of the science of medicine, and the difficulty of the art of healing, I trace that imperfection and that difficulty to several causes which I have endeavoured to explain.

In the first place, it is not possible to make to the object of our study and practice—the human body—any direct application of those powerful instruments of calculation which have been constructed, so to speak, by the aid of abstract reasoning, and which do admit of such ready and extensive application to those simple *relations* of matter that form the subjects of study in the sciences of astronomy, optics, and dynamics.

In the second place, we have not that unlimited command over living beings that we have over dead matter. We cannot handle the living body as we can a stone or a metal. We cannot bring to bear upon it the same powerful and subtle forces. So long, at least, as it continues living, we are dealing with a being in perpetual change, the very prime source of that change—the vital principle—being beyond our control, and only subject to be indirectly influenced by us.

In the third place, the object of our art is to bring about important changes in the human body, while the object of other important and comparatively perfect arts, such as the art of navigation, is not to change the state of anything, but simply by observation of the relative position of the heavenly bodies, of the points of the compass, and of conspicuous points of land, to conduct an inanimate mass, by means of adequate external natural forces, or artificial forces still more under control, to a given point on the surface of the globe. So, again, with the arts of construction. The architect and engineer do not attempt to work changes in the intimate composition of the materials which they use; they merely adapt them and fit them to each other, with a view to purposes of utility and ornament. Even the chemist, who *does* aim at bringing about internal changes in the matters with which he deals, has those matters entirely under his control, and can at will bring to bear upon them all the powerful and subtle agencies of which he has learned the properties and uses. On the other hand, in living vegetable bodies, and still more in living animal bodies, there is a force at work without which they would not be alive—a force which, whether it co-operates with our efforts to change their state, or strives against them, so mixes itself up with our efforts, as to render it in the highest degree difficult to determine what is due to the vital principle itself, and what to the agents we bring to bear upon it.

In the fourth place, the words which we use to designate diseases and disordered conditions of the body, are not mere words of *recognition*, like the names given to the planets or stars, but words of *identification*, which can only be safely applied after careful inquiry into the history and existing symptoms of each case; and these, be it recollected, unlike the similar terms of identification in use by botanists, or other

cultivators of natural history, are to be learned not by simple inspection and examination by the aid of instruments, but by the descriptions, often very inaccurate, of the patient himself.

In the fifth place, our science is most complicated, and our art rendered most difficult in practice, by the extraordinary differences which exist between one individual and another—differences so great as to make even diseases bearing the same name to present great varieties of character and degree.

And, lastly, the very remedies we use are subject to very considerable variations in purity and strength.

In this short recapitulation there is one source of difficulty arising out of the operations of the vital principle, whatever it be, to which I must briefly revert, that I may guard against any misapprehension of my meaning. I wish it to be very distinctly understood, that I do not attribute any part of our difficulties, as scientific or practical men, to our ignorance of the true nature of the *vital principle*. I deem it very important that we should not fall into this error; for that it is an error, you will at once perceive, when I remind you that no man in his senses presumes to say what the true and intimate nature of any of the great natural forces with which we are acquainted is. Sir Isaac Newton, who proved to us that matter attracts matter, and, having called that attraction *gravitation*, proceeded to calculate the amount of that attraction, and the precise rate of acceleration in falling bodies due to it in given intervals of time, did not presume to say what that principle, or force, of attraction was. He could not help speculating upon it; but he put forward his hypothesis with becoming hesitation and modesty. Nor when he showed that the elliptical motions of the planets were fully explained and accurately traced out, by means of a hypothetical principle of repulsion, causing masses of matter to fly off from each other, acting in conjunction with the attracting force of gravitation, did he pretend to say what the nature of this centrifugal force was. So also with the force which draws the magnet to the pole. So also with the elective affinity which determines all the changes of chemistry. The electrician and the chemist do not pretend to say what those forces really are. In like manner with the theories of light, heat, and electricity: we know nothing whatever of the intimate nature of any of these wonderful agencies. It is true, that by ingeniously devised experiments, and cautious reasoning upon them, we seem to be travelling towards a diminution in the number of recognised forces, as of recognised elements; but the same mystery will assuredly hang over the true natures of the smaller number of forces as now attaches to the larger number. We are profoundly ignorant, therefore, of the true nature of all forces; nor are we one whit nearer to a knowledge of it, though we can develope certain of them at will. We know no more about them than we know of the force of gravitation which we cannot develope, or of the vital force, in respect of which we are almost equally powerless. I say *almost equally powerless*, because, as we all know, it is in our power in many different ways to destroy life, and to impair the vital force.

To all intents and purposes, therefore, we are as ignorant of the true nature of other forces, as we are of the true nature of the vital principle. The difference in our knowledge of the one and the other is, that we *can* make direct and conclusive experiments upon *them*; but we cannot make such experiment upon *it*. We can find out by direct experiment how fast an apple falls to the ground, and what mathematical formula will rightly express the increments of force in equal intervals of time; and which of two or more elementary or compound substances a given element or compound will attract, and further, in what proportion or proportions it will unite with them; but we cannot in any manner measure, and set down in numbers, the intensity of the vital force. This then, and not a greater ignorance, on our part, of the nature of the force with which we have to deal, is the secret of part, at least, of our difficulties and perplexities.

If the science of medicine be so imperfect, and the art of healing so difficult, as I have represented them to be, it is incumbent on us, as scientific and practical men, to use our utmost efforts to render the one more perfect and the other less difficult, by improving to the very utmost all our logical methods, to examine the more important and promising among them with candour and impartiality, to purge our minds from errors and prejudices, and to labour assiduously in the direction which such examination may point out as offering the best chances of success. You will infer, both from the title of these lectures and the remarks which I have incidentally made in the course of this outline of sciences and scientific arts, that I look for the best results from the larger use of figures, and

more particularly from that special use of numbers known as the numerical method. Before I enter upon an examination of this method, I will ask you, from among the facts and general principles which I have sought to establish, specially to bear in mind, as admitting of constant practical application throughout the remainder of this short course, this one—that in the three analogous sciences and arts of agriculture, government, and medicine, the facts and events with which we have to do are brought about by the combined action of a great number of forces and causes. This principle lies at the foundation of that numerical method of which I am to speak in what remains of these lectures.

The numerical method is that branch or division of the universal science of logic which treats of the right way of using the figures which express the ultimate result of the combined operation of such forces or causes. To the sciences which have to do with such ultimate results, summed up in figures, the numerical method bears the same kind of relation that the pure mathematics bear to the mixed mathematical sciences. Wherever the pure mathematics can be brought to bear, they take with them precision of statement, terseness of expression, and compactness and force of inference. So is it with numbers generally in all the sciences, or parts of sciences, to which they are applicable. They express their meaning concisely; they admit of compact and lucid arrangement in tabular forms; and they facilitate the art of reasoning and the work of analysis. It is even possible, as I would have shown you, had time permitted, to make some use of the alphabetical symbols of algebra, as a means of rendering more easy, simple, and effective, the most difficult but most necessary of all our scientific undertakings—the comparison of cases.

The advantages, then, derived from the substitution of numbers for the corresponding words are by no means inconsiderable, and they are strictly analogous to those which arise out of the use of symbols in the pure mathematics. But there is another substitution of numbers for equivalent words which is scarcely less important: I mean, the distinct numerical statement of the number of observations which the physician has made in reference to any question of scientific interest or practical importance, in lieu of those general and indefinite verbal expressions, *often, repeatedly, generally*, and so forth, by which men often deceive themselves and mislead others as to the real amount and value of their experience; and I trust that I shall not be deemed very uncharitable if I express my belief that some of those who are loudest in their denunciation of what they call *statistics* are fully alive to the inconvenience which the use of numbers entails upon men who, more or less consciously, exaggerate the amount of their experience. And it is, I think, this same class of persons who are most in the habit of objecting to the insufficiency of such numerical statements as do not comprise a very large body of facts. They are apt to misunderstand the real object of such comparatively small collections of facts, and to attribute to the collector the ambition of establishing a numerical law, when his real object was merely to state the precise extent of his information.

To the use of numbers, then, in the cause of science, we are justified in attributing the virtues of terseness of expression, clearness of exposition by tabular forms, and precision and truthfulness in setting forth the amount of our experience. Unhappily, there are too many persons usurping the titles and functions of medical men, who habitually make false statements both of individual cases and of cases in the mass; but to them my remarks do not apply. It would be useless to recommend to them the substitution of numbers for words; but for men who love truth, and wish to promote truthfulness, the substitution of numbers for loose verbal statements is the first step which they should take.

This, however, is *only* the first step towards the attainment of a sound numerical method. Numbers are for it what fibres of silk, cotton, or wool, are for finished fabrics. They are a sort of raw material, requiring careful selection and preparation, and very skilful manipulation, before they can be wrought into a true scientific fabric. Our units must be homogeneous, that our general laws may be sound; and, in submitting the numerical method to a rigorous examination, we must first begin with the units of which our numbers are made up, and then proceed to consider the numbers (whether they be aggregates or averages) which result from our scientific manipulation of the units in question.

Now, the units which compose our figures are not always of the same kind. Sometimes they are simple units, such as a pauper, a criminal, a prisoner, a debtor, a patient; or simple events, such as recovery or death from a given disease; at other

times, they are units of variable magnitude, such as the number of the pulse and respiration, the height of the thermometer or barometer, the specific gravity of the urine, the age at death of a particular class of persons, and such like. The social and moral sciences have to do chiefly with the first order of units; the physical sciences with the second. The statistic records the number of births, deaths, and marriages; the number of deaths from different diseases; the number of paupers and thieves, of debtors and bankrupts; the number and value of articles of export and import. On the other hand, the astronomer, the mechanician, the chemist, and the meteorologist, are mostly busied in recording the average results of observations and experiments in which each unit is a variable number, consisting itself of equal units of weight or measure marked on the scales of instruments, such as the watch, the barometer and thermometer, the dynamometer, the urinometer, etc.

Though these two kinds of units differ in the manner just stated, though the one kind is simple, and the other compounded of a variable number of equal smaller units, they resemble each other in one very important particular. They are, both of them, the expressions of the simple ultimate results of the simultaneous or successive operation of several causes acting individually with varying force, and collectively in very variable combinations. The price of a commodity is the result of a multitude of operations of commerce, manufacture, and trade; the death of a man at a certain age is equally the result of a series of favourable or unfavourable circumstances operating during the whole of his life on a constitution already predisposed to certain maladies by causes acting even before his birth. Even the mysterious agency to which we give the name of *chance* is, as I shall state more at length by and bye, merely a combination of forces, of which the elements unite in ever-varying permutations of number and intensity.

Now these facts, whether of the one order or the other, are nothing of themselves. They are valuable only when brought together in masses. They are as the twig to the faggot, the ear to the sheaf, or the soldier to the regiment. It is their number which gives them strength and importance. But why is this? What necessity is there, and how does it arise, for collecting large numbers of such simple facts? The answer is obvious and easy. The facts of this order, simple as they are, either differ from each other in their numerical values, or they differ in the circumstances by which they are brought about. One man's pulse or breathing has not the same frequency as another man's pulse or breathing; the height of the barometer and thermometer is constantly changing; people die at all ages, from birth to decrepitude; criminals, prisoners, debtors, sick men, exist in various proportions to the population in different countries and districts, among different classes, at different ages, and in different seasons; and the same disease has different issues in different patients. These differences, too, are so considerable that several facts of the same order have to be brought together before we can hope to exhaust all their varieties, and before we can strike an average which shall truly represent the state of the case both absolutely and for the purposes of comparison. Hence the necessity of numerous facts, of averages, and of a logical treatise, under the name of the numerical method, on all the modes of dealing with these facts, for all the many purposes to which they are applicable.

The principles and rules of this *numerical method* must be reserved for separate treatment.

[To be continued.]

PRESENTATION OF PLATE TO JOLLIFFE TUFNELL, Esq. On April 30th, a deputation of the medical officers of the army waited upon Mr. Tufnell, Regius Professor of Military Surgery, Dublin, for the purpose of presenting him with a testimonial expressive of the sense of their obligations to him for his unwearied and successful exertions to improve the position of the surgeons of the army, consisting of a massive epergne and candelabrum. The plateau represents a series of rocks, the upper surface exhibiting a highly polished surface of mirror silver, and the shaft a palm tree, beneath which is represented a Hindoo woman in dulled silver receiving the fruit of the tree from her child from above. The design is to illustrate the restoration of peace in India. The epergne bears the following inscription:—"Presented to Jolliffe Tufnell, Esq., Regius Professor of Military Surgery, Dublin, by the Medical Officers of the British Army, in acknowledgment of his unwearied advocacy of their rights and staunch support of their claims." Dr. Humfrey, the senior medical officer in Ireland, Inspector-General of Hospitals, presented the testimonial.