AN ADDRESS

ON

THE IMPORTANCE OF THE STUDY OF
PHYSICAL SCIENCE IN MEDICAL
EDUCATION.*Delivered at St. Mary's Hospital, May 22nd, 1869.*

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WHEN the honour of presiding at this meeting was proposed to me on the ground that, having devoted some time and thought to physical science, I might with effect urge its importance for medical education, the task seemed an easy one; and, in a weak moment, I yielded to the temptation. On thinking the matter over, however, I found, too late for escape, though not for repentance, that the axiomatic truth of the thesis on which I was to discourse formed its great difficulty. Euclid could not prove that things which are equal to the same thing are equal to one another, in any other way than by stating the proposition. How is one to urge the importance of a branch of study in aid of that profession which depends entirely on that branch of study? Medicine without chemistry and physiology, surgery without anatomy and mechanics, would indeed be the play of *Hamlet* with the part of *Hamlet* omitted. I must, therefore, take another starting point; and, assuming that all connected with these schools are as fully convinced as I am that the study of physical science is the basis of medical education, I must rather address myself to those without, and endeavour to shew what the healing art would be without science.

The following anecdote, in Faraday's own words, furnished to me by my friend Dr. Bence Jones, will not be a bad illustration.

"July 24th, 1819, Machynlleth, Merionethshire.—I wanted a little alcohol; and, having found out a doctor's shop and a spruce doctor's man, got some. I then asked for a little spirits of salts, hoping I could have it in a glass stoppered bottle. The man found me a bottle, having emptied one of his preparations out of it, and would then have poured in acid; but it was not the acid I wanted, and I again mentioned spirits of salts to him, willing to allow every thing to the possibility of his ignorance of the scientific name, but at the same time adding 'muriatic acid', to save his credit, if possible. He now seemed to understand me; and, reaching down another bottle, again prepared to pour, but I stopped him. 'It is muriatic acid that I want.' 'This is muriatic acid, sir.' 'No; that is nitric acid.' 'They are the same, sir.' 'Oh, no; there is a little difference between them; and one will not do for me as well as the other.' I then endeavoured to explain that the one came from nitre; the other from common table-salt. He comprehended a difference between these two bodies, but not between their acids; and he brought out a *Pharmacopœia*, and, opening it at Muriatic Acid, uttered the Latin name and synonyms fluently and with great emphasis, endeavouring thus to prove to me the two were alike! I was really ashamed to correct the doctor; and, if I had not been under the necessity of vindicating my contradiction of him, should have left him in ignorance. However, at last I made him comprehend, from his own book, there was something like a difference between these acids; but I don't think he shut the book much improved by the affair. I could scarcely afterwards look at the man. If he had any feeling—he appeared to have a considerable stock of pride—he must have felt himself extremely lowered in the eyes of strangers, and before his own companion, who was standing by. I began to rummage his bottles for muriatic acid myself; but I must do him the justice to say he first found out what little they had (about an ounce), and that he really compared it with the nitric acid—I hope for information, though the object professedly was to shew me how like they were. Is it not strange that a man so ignorant of his profession should still appear respectable in it; or that one so incompetent should be entrusted with the health and lives of his fellow-creatures? Had I seen nothing more than his harshly dictatorial manner to a poor woman who came in with a prescription and a bottle in her hand, I should have concluded him to be a man who had attained the utmost knowledge of, and confidence in, his art. Seeing what I did, I cannot enough condemn the being who, without a knowledge even of the first requisites of an honourable but dangerous profession, assumed to himself its credit and its power, and dashed at once upon

human life with all the means of destruction about him, and the most perfect ignorance of their force."

Another instance of the dangers of ignorance occurred to myself twenty-five years ago. Suffering from an illness for which strong doses of opium were required, I obtained a prescription which concluded with the words "quarta quaque hora sumendum." Fortunately for me, though perhaps not for you, I read it; for, when the bottle came, it was labelled "To be taken every quarter of an hour", which direction would have given me sixteen times the prescribed quantity; and, had I followed it, you would have been spared the trouble of listening to me to-day. Another not uncommon mistake arising from ignorance of chemistry was that, in prescriptions of two or more substances, each of which singly was known to produce a certain effect on the human body, the practitioner considered that by mixing them he would get the effect of each; whereas, if even a slight chemical change took place on admixture, the resulting compound or precipitate produced a totally different effect from any of the components, and was, consequently, injurious, if not fatal.

If there be one species of cant more detestable than another, it is that which eulogises what is called the practical man as contradistinguished from the scientific. If by practical man is meant one who, having a mind well stored with scientific and general information, has his knowledge chastened, and his theoretic temerity subdued, by varied experience, nothing can be better; but if, as is commonly meant by the phrase, a practical man mean one whose knowledge is only derived from habit or traditional system, such a man has no resource to meet unusual circumstances; such a man has no plasticity; he kills a man according to rule, and consoles himself, like Molière's doctor, by the reflection that a dead man is only a dead man, but a deviation from received practice is an injury to the whole profession.

The anecdotes with which I commenced, though doubtless not applicable to the present day, or to this metropolis, shew the frightful power which is wielded by medical men. How many fatal blunders may occur we know not, for those who commit them are generally careful to keep the eleventh commandment; viz., "Thou shalt not be found out." How much harm, however, must have been done, not by ignorance such as this, but by what I may call accredited ignorance; i.e., by received modes of treatment, which the intelligent practitioner despised, but dared not depart from. The practice has so recently ceased, that I can hardly venture to remark on it, by which a medical man was paid only for, and in proportion to, the quantity of drugs he administered; so that in very many cases—in all, more or less—the most honest practitioner could only support his family by giving sham medicine, or that which would produce no ill effect. Even this was difficult, as I need not tell you that a glass of water does harm if it is not wanted. What injury, again, you now know to have been effected by the blind and almost compulsory following of systems—from the time of the Dogmatists and Empirics to the phlogistic and antiphlogistic doctors, and from them almost to the beginning of the present century—what terrible results must have followed from ignorance of physical science, and of its judicious application to medicine.

Physician; i.e., student of nature; but what is nature? Not a personified existence, as she is apt to be conceived, but simply what is, what we observe, or what we deduce or generalise from observed phenomena. Observation teaches us, when directed to organic beings, that they have an adaptability to circumstances, arising, probably, from long continued adaptation; but the limits of this adaptability are exceedingly difficult to ascertain. To know when and to what extent change will benefit, and when it will injure or destroy, requires the highest skill of the experienced and scientific physician. The so-called nature of the hot-house grape, of the domestic cow, differs from that of their wild congeners—they suffer from different diseases, and require different remedies.

What is disease? Speaking crudely, is it anything but too sudden a departure from uniformity of action? The function of the whole or of some part of an organism is rapidly accelerated or impeded; the other organs cannot keep pace with it; the structure becomes changed, because those motions which preserve its form, those secretions which feed it, are out of time with it; and either the destruction of the organism, or the setting up of a *quasi* independent life, ensue. Things have become what they are by slow alterations during ages, and their power of adaptation will not bear sudden changes. What can enable you to detect and to remedy this? First, a knowledge of the functions of the body in its healthy state; second, a knowledge of the cause of the derangement. Can you proceed one step in these inquiries without a knowledge—aye, a profound knowledge—of physical science? Could we tell, without a knowledge of chemistry, only attained in the present century, why train-oil is good for the Esquimaux and rice for the Oriental? Until a few years back, we did not know that fat, and not

lean meat, was the best food for those who undergo great but rather sudden physical exertion; and even now we do not know how much sugar, starch, or fat, and how much nitrogenous food are suitable for given habits; how much lime, how much phosphoric acid, etc., are required; for a man without bones would not succeed, and bones cannot grow out of nothing, or substantially from other elements than their normal constituents. The sportsman's appetite may guide him with tolerable accuracy, but you have to treat the lawyer and the statesman, and to tell them how they are to economise their powers under the most trying changes of condition. And your difficulty is the greater that you are not allowed to experiment. If a physician could select, say ten patients labouring under similar disorders, and apply a different mode of treatment to each, he would greatly promote the science of medicine; but he would, doubtless, be sentenced to penal servitude for manslaughter.

Of the first two steps to physical science—observation and experiment—one is, to a great extent, denied you. How can you supplement it? Very feebly, I own. You have, to some extent, *post mortem* dissection, and you have comparative anatomy and physiology; but you have a little more: you may substitute for experiment, observation of individuals; or, better still, of classes, placed by their necessities under circumscribed conditions. Thus the miner would give you some aid as to what degree of health was compatible with exclusion from light and respiration in an abnormal air; and what diseases are produced by such conditions of existence. The fisherman could assist you as to what are the effects produced by a fish diet, etc. Indeed, there is some scope for individual experiment. Fick and Wislicenus made valuable experiments on themselves in their ascent of the Faulhorn. Regnault made valuable experiments on animals (hardly chargeable, like vivisection, with cruelty) by keeping them in different gases, and supplying them with special food.

Physical science applied to these cases is at present in its infancy; but can anything else do anything? It provokes me to hear classically educated men speak in patronising terms of the introduction of physical science into general education, such as, "I do not object to physical science; I have no prejudice against it." Why, you might as well object to breathing, to eating, to seeing.

The immense importance of scientific education for medical students will, I trust, induce all interested in the subject to aid the endeavours now being made to introduce the study of physics into public schools. A committee of the British Association, appointed during my presidency, recommended in its report that three hours in the course of each week should be devoted to science. Even this modest suggestion has been deemed by some of those who are well acquainted with the difficulties of changing traditional habits of long standing, to be too daring an innovation! but I trust that this small allotment of time may be granted without derogating substantially from the accomplishment of construing, parsing, and composing Greek verses. Not that I at all condemn classical or historical education. To understand the present we must read the past; and having a long course of time to select from, we can take the best authors as our guides; but I should incline to let a young man read Shakespeare as well as Virgil, and give him a dose of Galileo as well as of Aristotle.

To my mind there is a great fallacy in the prevailing notion that the most successful education is that which is restricted to a very limited range of subjects. Of course, there is great error in the opposite extreme; but I am sure many of those I address will bear me out in saying that the mind is rendered more elastic, and that the student learns more by some variety in study. Many, who cannot get beyond a limited degree of attainment in one given line, will be capable of reaching that and an equal degree in three or four other pursuits. We see this strikingly exemplified in accomplishments; a man may never pass a certain limit of excellence in playing the flute, in cricket, billiards, or fencing, though he devote all his time to one of them, yet he may attain a fair amount of skill in all. Recent experience has proved that those whose previous training has been formed on a wide basis, have shown the greatest aptitude even for special study.

It is too long since I graduated at Oxford for me to pronounce on the present state of our Universities. What then forcibly struck me was the comparative neglect of pass men, or those not expected to distinguish themselves, in favour of those who promised to raise or keep up the status of their respective colleges. Yet the former need the attention of the tutor far more than the latter; and there are few whose minds will not respond to the teacher's efforts, if the right note be struck.

I am told that, in the London medical schools, somewhere about one thousand young men are educated. The need of science in the medical department of the country ought, if it were useless in other departments, to bring home in a practical form, to those having influence on

establishments for secondary education, the necessity of introducing physical science as a necessary part of the course of study.

Chosen for the task of to-day as having laboured in the field of physics, though not of physic, I will venture, at the risk of getting out of my depth, roughly to sketch the relations of science to the healing art, and how illimitable should be the scientific acquirements of the physician or surgeon.

To understand an ordinary machine—*e. g.*, a watch or clock—the action of one force alone has to be considered, such as a falling weight, or the reaction of a coiled spring, etc. In a steam-engine, the consideration of another force—heat—has to be added. In a voltaic battery and its effects, the nearest approach man has made to experimental organism, we have chemical action, electricity, magnetism, heat, light, and motion. But in the human body we have all these (and possibly other forces or modes of force of which we are at present ignorant), not acting in one definite direction, but contributing in the most complex manner to sustain that result of combined action which we call life; and so beautifully are all these inter-related, that, as Cuvier could pronounce upon the general characteristics of an animal from examining a single bone or piece of bone, the histologist may now to some degree, and at no distant future may reasonably be expected to pronounce with tolerable certainty on the temperament and mental habitudes of a man from examining a portion of his skin—a new species of palmistry, founded on knowledge, and not on superstition.

An acquaintance with the motions, sensible and molecular, which the different forces produce in the human body, the means of stimulating them when torpid, of checking them when too active, of apportioning them by diverting forces from one organ to another, as happens frequently without the physician's aid—what is all this but physical science? Medicines, I need not say here, give no life, though they may take it away; they only promote, arrest, or divert the action of different natural forces on different organs. They may cure the totality of the organic being by such diversion of force, or by destroying derived or parasitic vitality (fungoid growths, which detract from the general apportionment of force, or eat into vital organs); but they do not and cannot create force.

But far more than drugs can do is done by the eminent physicians of the present day in what I may term regulating the movements, internal and external, of the body, after they have, by improved skill in diagnosis, detected the causes of the excess, the deficiency, or the irregularity, of motion which produce the disease. Half the world, in the present day, are said to die of repletion, and half of inanition. It is not, however, mere quantity of food, but its nature and chemical action, which is better and will be better understood; food for repairing the structures; food for enabling them to go on with the varying movements; chemical force transformed into heat and motion, and adapted to habits and circumstances, to exercise and rest, to temperature and climate, to mental activity and sleep. So, with respiration, oxygen enters the lungs an element, and returns in carbonic acid; but in so doing it has enabled the lamp to burn; it has removed carbon that has done its work; it has kept up the involuntary, and ministered to the voluntary motions.

Applied to the respiratory functions, chemistry might offer a field of inquiry not much trodden since Dr. Beddoes established the Pneumatic Institution at Bristol; not merely by inhalation of gases *à la* *à*, but by a judicious admixture of small portions of given gases with the ordinary air. Thus a small increase of carbonic acid in the air tends to produce somnolence: might not this be carefully tried in cases of extreme nervous excitability and insomnia? Ozone, again, doubtless has its effect, probably of somewhat a converse character to that of carbonic acid. Such remedies might be free from the disturbing influence on other organs which the administration of sedatives or stimulants by the stomach frequently, always perhaps in degree, occasions.

I offer these crude suggestions rather as illustrations of my argument than as having any founded reliance on their efficacy. Experiment alone can determine this.

As the engineer gives air, water, and coal, to his engine in proportion, and only in proportion, to their expenditure, so should food, air, and exercise be apportioned by the physician. The machine or the part of it that is worn should have rest and repose; the machine that is rusty should have work. I might suggest a hundred problems relating to the human economy which science alone can and will some day answer. What is the effect of phosphorus on the brain and tissues? Why, when administered, is it poisonous in one form, and innocuous in another? Why do some poisons affect the brain, others the heart, others the stomach? What are miasmata? Do infectious diseases result from a chemical state of the air, or from organic monads contained in it? What is the effect of light on health? Has the inhaled nitrogen of the air any, and what, effect on the organism of animals? etc. How vast are the fields of inquiry! The dawn of science has even now scarcely succeeded to

the darkness of empiricism. Individual and combined effort will, I trust, rapidly bring more light.

Not the least important branch of scientific education is, in my humble judgment, a practical acquaintance with instrumental manipulation. I speak not of the surgeon's appliances—those are an obvious necessity; but of an early familiarity with such agencies as electrolysis, blowpipe analysis, or, above all, the microscope. The first of these—electrolysis—offers a wide field of information to the student. The secondary compounds formed at the poles of a voltaic battery, particularly with organic substances, are most curious and instructive objects of investigation. Blowpipe analysis is also most useful, and the apparatus may always be at hand. As to the microscope, the physiologist's *valde mecum*, I need not insist on its value. More is learned in an hour by the study of one of these, well explained, than by months of reading. Manipulation, moreover, should be learned young: the hand and head thus learn reciprocally to aid each other.

A few words on hospitals. They are, in my humble judgment, the only charities for which I would not have a prohibitory law of mortmain, not suddenly but gradually, introduced. Mortuary endowments are apt to transmit and clothe with authority the errors of past times; they are apt to be the offspring of caprice or undue persuasion, so likely to be uneconomically conducted. There are no living vigilant subscribers to scrutinise the application of their funds; and the reproach to a complainant is ever ready, "Why should you interfere? we are not dealing with your money." I cannot recognise the right or advantage of any man being able by a mere flourish of his pen at some particular period of his life, and that generally when his faculties are not in their best state, to dictate how men should act in a distant future, the requirements of which he cannot know, and when he himself would probably have entirely changed his views. Speaking for myself, I would, as a general rule, let the charities (I use the word in its wide legal acceptance) of the day be supported by the people of the day; but I incline to except hospitals for the sick, the infirm, and the deranged; because they are managed by the gratuitous services of medical men; because they afford help to those who most require and can least misuse it; because they are tied to no formulae, but call into action the most advanced knowledge of the day; because they form the most valuable school for the most valuable knowledge; and because (though this may be common to other charities) they require a permanent local habitation. My observations on endowments are not intended to apply to untrammelled gifts by living men. The test of parting with property, and giving up its enjoyment, by the living and healthy owner, is a tolerable security against some of the abuses I have indicated. The number of Peabodys, moreover, will never probably be excessive; but even their gifts should be subject to control, and the State should always have a power of direction and interference.

St. Mary's Hospital and School are, I believe, unendowed; so my words have no present application here; but, having often discussed the subject with eminent men, I take this opportunity of expressing my notions, though much more briefly than the subject demands.

The clock warns me that I must conclude. After delivering prizes, the gaining of which has depended solely on merit, I may be expected to end with the usual encouraging peroration, that industry and ability command success; but I cannot, except in a modified form, agree to this copy-book maxim, when applied to your future struggles with the world. Doubtless, few who are prudent, energetic, and industrious, fail to attain some fair degree of worldly success; but the race is not always to the swift, or the battle to the strong. Circumstances affect efforts, promoting, arresting, or diverting them. The road to success is often that which a high-minded man cannot travel; he cannot learn to fetch and carry, to subserve the interest of a patron or a mob. I do not seek to undervalue success: duty to yourselves and those whom you may bring into the world enjoin its pursuit in moderation. But I would fain endeavour to inculcate upon my younger hearers a higher motive than the mere hope of fame, wealth, or power. If these come by an unswerving career, make good use of them; if not, console yourselves with the conviction that those who are said to be in power are frequently the veriest slaves in existence; that the improvement of our race is more promoted by those who think than by those who act; that some degree of martyrdom—not that which trumpets its sufferings, but silent, proud, unappreciated martyrdom—is commonly the lot of those whose labour tends most to advance mankind, for upon them rests the burden of opposing existing prejudices, and unsettling vested interests. Have courage to risk this. Your most noble profession offers the grandest field for human exertion—the widest scope for progressive improvement. To assuage human anguish, to restore the child to the parent, the husband to the wife; to convert despair into hope and hope into fruition, will be often your lot; to see the least selfish parts of our common humanity; to teach how the in-

dividual, how society, may be regulated, so as to produce the greatest sources of happiness—sound minds in sound bodies—belongs to yours more than of any other calling. You will meet with hard rebuffs, but "in the reproof of chance lies the true proof of men." Meet failure without repining, and success without exulting. Have but one rule of life, "Fais ce que je dois, advienne que pourra."

ON THE USE OF OBSTETRIC INSTRUMENTS.*

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HAVING, on a former occasion, described the instruments used for dilating the os uteri during the first stage of labour, I now pass on to those which are employed to aid the descent of the child's head during the second stage. The fillet, an instrument formerly much employed in midwifery, was a band of silk, cord, or leather, with the addition of a piece of cane or whalebone to facilitate introduction. It was passed over the chin, or some prominent part of the head, and used as a simple tractor. But as it is now obsolete, having long ago been condemned by accoucheurs as inefficient, I need make no further allusion to it, but proceed to describe those instruments which are now in very general use.

The vectis, although in every way inferior to the forceps, is still very much resorted to by some practitioners. It acts both as a lever and a tractor, and the chief advantage it possesses is the facility with which it can be introduced. This, however, is a very small set-off against its proved and acknowledged inefficiency. It is not capable of being used with sufficient power to effect delivery when labour pains are absent; and even when pains are present, it is of little avail when rapid delivery is necessary. The instrument is of most service, I think, when we wish to correct malpositions of the head. For instance, I have found it very serviceable in presentations of the brow, where, as is generally the case, it is found impossible to push up the forehead so as to allow the occiput to come down. By passing up the vectis over the chin, that part may be brought down, and the presentation altered into one of the face, which is in every respect more favourable. Or again, in face-presentations, if the chin be turned towards the hollow of the sacrum and do not readily engage itself underneath the pubic arch, it may be brought round into that position by the vectis. Also, when the head presents with the forehead in the anterior semicircle of the pelvis, we may often succeed by means of the vectis in bringing that part round into the posterior semicircle. Where, however, it is necessary to assist delivery, because the head is arrested during its descent through the pelvis, the vectis is a singularly inefficient instrument. If used as a tractor only, it is almost sure to slip if much traction be made; and if as a lever only, it is unsafe unless we make the hand a fulcrum, and then there is very little power, because the hand is not a sufficiently fixed point. The best method of employing this instrument, both as a lever and as a tractor, has been explained by Dr. Robert Barnes, in one of the excellent series of Lectures on Obstetric Operations, which have been lately published by him in the *Medical Times and Gazette*. He points out that the vectis should first be applied over the occiput, and that part drawn down until it is lower than the vertex, and then that it should be applied posteriorly over the forehead and the same manœuvre executed, until, at last, the head is brought down through the outlet of the pelvis. In using the vectis, however, it must be remembered that we depend very much on the co-operation of the labour-pains; and the first result of the operation I have just described is, to convert the ordinary presentation of the vertex into one of the occiput, which, all who have had much experience of these cases know, is not nearly so favourable. The same thing may be said when the forehead has been depressed by the vectis, so that it may well be questioned whether we do not impede nature more, by rendering the presentation less favourable, than we assist her by our extractive efforts. For my own part, I am quite convinced that, when the head is arrested in its course, and the necessity of instrumental interference has been once decided upon, it is far better to have recourse immediately to the most efficient instrument, viz., the forceps, than first to waste time by making efforts with the vectis, which very probably will prove ineffectual, and at last be obliged to use the forceps under less favourable circumstances. For these reasons, I never now use the vectis, except to correct malpresentations.

The instrument, beyond all others, on which the accoucheur depends, is the forceps. No better evidence of its value can be adduced than was afforded by the vast number of specimens shown at the London Exhi-

* Read before the Bath and Bristol Branch.