LECTURES ON THE HISTOLOGY OF THE EYE:

(BEING THE ARRIS AND GALE ANATOMICAL LECTURES.)

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BY

JOHN WHITAKER HULKE, F.R.S., F.R.C.S.,

Assistant-Surgeon to the Middlesex Hospital, and Surgeon to the Royal London Ophthalmic Hospital.

LECTURE II.

MR. PRESIDENT AND GENTLEMEN,—We were occupied last Thursday with the minute anatomy of two of the non-vascular parts of the eyeball—the cornea and vitreous humour: to-day we come to the most vascular of all the ocular tunics.

The *Tunica Uvea*, so named from its resemblance to a grape or large berry, *uva*, consists of two segments—the iris and the choroid—which differ in their principal anatomical constituents and in the offices which they subserve in the physiology of vision, and agree mainly in both of them containing numerous blood-vessels and much pigment.

The *Choroid* corresponds to the coat of lamp-black with which we line the interior of the camera obscura, and serves the same purpose, absorbing the incident rays, and so lessening dispersion in proportion to the intensity of its pigmentation. But, the eye being a living camera, the choroid has additional functions of another kind. It directly ministers to the nutrition of the bacillary stratum of the retina in man, as also to that of all the retinal strata in those animals whose retinae are devoid of blood-vessels.

The *Iris* corresponds to the diaphragm in the cornea. Stretched across the anterior chamber, it stops out the most peripheral rays, which, in its absence, would pass through the edge of the lens, and in this way it lessens spherical aberration; then, by varying the size of the pupil, it regulates the quantity of light admitted to the retina; and, finally, it is an accessory of the apparatus of accommodation, although not in man an actual factor.

The iris is essentially a *muscular organ*. The contraction and dilatation of the pupil are due to muscular irritability, and not to vascular erectility. Their continuance after the heart has ceased to beat, and even after the head has been severed from the body, are facts which place this beyond discussion.

In mammalia, the muscular tissue is of the unstriped kind; while in birds and reptiles it is striped. One of the most useful chemical agents for demonstrating it is the chloride of palladium. The iris should be placed in a solution of this, containing from one-fourth to one-eighth per cent., until it acquires a deep straw tint. The palladium chloride hardens the tissue, without making it so granular and opaque as chromic acid does; and it beautifully preserves the nuclei. With this reagent, its demonstration is easy and certain in the eyes of white rabbits, where it is unobscured by pigment, which conceals it in human eyes.

The cells, which are not easily individually isolated, are long spindles containing a rod-like nucleus. They resemble closely the cells of the larger organic muscles. A cell-wall distinct from the protoplasm cannot be distinguished. The cells cohere in small flat bands, and these again combine in larger bundles. In man, I believe also in mammalia generally, in birds, and in reptiles, the muscular bundles are disposed in two sets, which have a radial and a circular direction, and constitute a sphincter and a dilator muscle of the pupil. (Fig. 1.)

In the white rabbit, as also in man, the muscular bundles of the sphincter pupillæ are disposed with great regularity in lines concentric with the pupil, at the edge of which they form a very distinct band upon the anterior surface. On the back of the iris, the outer border of the muscular ring is less distinct; and here, intersecting the radial bundles of the dilator, a thin layer of circular fibres is traceable for some distance towards the great circumference of the iris.

In birds, the circular bundles are not restricted to the neighbourhood

of the pupil; but, as H. Müller long since pointed out, they extend over the whole surface of the iris as far as the periphery. The dilator pupillæ consists, in this animal, of slender bundles running along the posterior surface of the iris from near the great circumference towards the pupil, separating and combining again in a plexus with long narrow meshes. On nearing the sphincter pupillæ, they spread slightly, and, intersecting with one another and with the bundles of the sphincter, are lost.

The peripheral relations of the radial muscular bundles are less easily made out. The difficulty is occasioned by the greater thickness of the iris, and by the parallel direction of the very muscular arteries. I am inclined to think that the bundles attach themselves to the elastic fibres, which the ligamentum pectinatum iridis prolongs inwards to the iris. This very remarkable net of elastic tissue, which fixes the great circumference of the iris to the margin of the anterior chamber, is derived

Fig. 1.

from the posterior elastic lamina of the cornea, which in my last lecture I mentioned as having peripheral relations with the ciliary muscle, iris, and sclerotic. These I shall now explain. The lamina at the circumference of the cornea resolves itself into fibrous tissue. This dehiscence begins first on its anterior surface, and goes on until the whole membrane is converted into fibres, which take three principal directions. One set passes backwards and outwards to the sclerotic, behind the circulus venosus in Schlemm's canal; another set goes directly backwards to the ciliary muscle; and a third set springs across the margin of the anterior chamber to the great circumference of the iris, on the anterior surface of which they form a network remarkable for its hard-stiff outlines, from which fibres are produced upon the front and in the substance of the iris for a considerable distance towards the pupil.

The *blood-vessels* of the iris are very numerous. Its arteries come from the arterial circle formed by the inosculcation of the two long posterior ciliary arteries, and known as the *circulus arteriosus iridis*. The mode of formation of this arterial circle is very variable; but the ordinary plan is, that each of the two long posterior ciliary arteries divides upon the outer surface of the ciliary muscle, near its front, into a couple of primary branches, which separate and encircle the iris, and meet the corresponding branches of the other long ciliary artery. The arterial circle thus made sends branches backwards to the ciliary muscle; others inwards to the ciliary processes; and a third set run forwards to the iris through the ligamentum pectinatum. These latter have, as Leber notices, very thick muscular walls. They run from the great circumference of the iris towards the pupil with a straight or wavy course, detaching branches to the capillary net, which is very abundant, especially at the anterior surface of the iris. On reaching the lesser circle of the iris (the little circle of minute irregularities on the front of the iris near the pupil, which marks the attachment of the foetal pupillary membrane), the now greatly diminished arteries join here in a second arterial ring, the *circulus arteriosus minor iridis*. From the inner border of this, capillaries extend inward, encroaching slightly upon the sphincter, but not quite reaching the edge of the pupil.

The veins of the iris lie nearer its posterior than its anterior surface. They pass backwards, and, joining the veinlets of the ciliary processes, convey the venous blood from the iris to the vasa vorticosae.

The iris receives its *nerves* from the ciliary plexus—that exquisite net on the outer surface of the ciliary muscle. I can strongly recommend osmic acid for their microscopical demonstration. If the iris be placed in a solution of this acid holding about one-fourth to one-half a grain per cent., for about twenty-four hours, we get the nerves blackened, and the muscular tissue only slightly stained. Stronger solutions are not so useful as the weak ones, because they blacken more, and less

discriminatingly; and, if the preparations are left a little too long in them, everything is black alike, and indistinguishable. (Fig. 2.)

Fig. 2.

The nerves of the iris, most easily studied in white rabbits and guinea-pigs, are numerous. The larger bundles, containing several fibres, converge from the great circumference of the iris towards the lesser circle, forming, in their hitherward course, an open plexus, the larger meshes of which are occupied by a finer net. At the lesser circle, the nerves combine in a circular plexus, from which single fibres are traceable inwards in the sphincter nearly to the edge of the pupil. The coarser bundles have a very abundantly nucleated neurilemma. The nerve-tubes vary greatly in size, ranging between $\frac{1}{300}$ " and $\frac{1}{100}$ ". All such tubules have a medulla; they are dark-edged fibres; while the "mallest pale fibres which I have traced were not more than $\frac{1}{1000}$ " in diameter.

The interstices between the muscular bundles and the meshes of the vascular and nervous nets are filled with a homogeneous connective substance, in which simple, jagged, and very large, irregular, and much branched connective-tissue corpuscles, plentifully occur. Many of these contain a granular pigment, which, by its quantity and distribution, produces the different colours of the iris.

The back of the iris is overlaid with a coat of pavement-epithelium, loaded with granular pigment, which is sometimes called the uvea or uveal surface. The cells are less regular in size and shape than those of the corresponding epithelium of the choroid.

The front of the iris also has an epithelium. It is much more delicate than that on the back, and more difficult to demonstrate. Weak solutions of nitrate of silver are useful for this purpose.

We now pass, gentlemen, to the *Choroid*, in which we recognise two subdivisions—a larger posterior portion, reaching from the optic nerve forwards as far as the jagged line which marks the termination of the nervous retina, ova serrata; and a smaller anterior portion, lying between this and the iris, which we call the ciliary body. So much of this latter as belongs properly to the apparatus of accommodation, it is not my purpose to describe in this lecture. My present remarks will relate more particularly to the posterior segment. Its principal characteristics are, its pigmentation, and its great vascularity. This latter much exceeds that of the iris; and, further, there is a peculiarity in the arrangement of the blood-vessels—the capillaries lie apart from the large vessels.

Enumerating the different tissues in the order in which they occur in passing from the inner to the outer surface of this coat, we first meet with a pavement-epithelium, borne upon a structureless membrane, the elastic lamina of the choroid (fig. 3); then the capillary net, called the chorio-capillaris, and by the older anatomists the tunica Ruyschiana; next, the choroidal stratum, in which the large vessels are imbedded; and, finally, a looser connective tissue, which unites the choroid and sclerotic, named sometimes the lamina fusca.

The choroidal epithelium is formed of a single layer of flat polygonal, mostly hexagonal cells, containing a nucleus and some granular pigment. (Fig. 4.) In fair persons, the pigment is present only in moderate quan-

Fig. 3.

tity, and of light orange tint, and not enough to hide the nucleus from view; but, in swarthy Europeans, the quantity and intensity of the pigment are greater, and the nucleus is often concealed by it. In the darker Asiatic races and in Africans, it is usually quite hidden by the

Fig. 4.

mass of black-brown pigment which loads the cells. In Albinos, in the white choroid of cetaceans, and upon the glistening silvery portion of the thyroid called the tapetum lucidum in ruminants, solipedes, and carnivores, the epithelium is also present, but it is devoid of pigment. In birds, reptiles, fish, and amphibia, brushes of pigmented tissue pass inwards from the epithelial cells between the retinal buccilli. In man, the diameter of the cells ranges between 1-1400th and 1-2150th of an inch; their average is about 1-1450th. These dimensions are occasionally far exceeded by the cells which occur in the black spots and fringes which generally surround the decolorised patches which mark former inflammatory foci. Some of these are four or six times the size of that of the largest normal cell; they are quite colossal microscopic structures, reaching $\frac{1}{100}$ ", and even $\frac{1}{30}$ "; while upon the decolorised patches the epithelial cells are diminutive, ragged, and scattered.

The epithelium rests on a very distinct structureless membrane—the *elastic lamina*. This is often the seat of circumscribed thickenings, which begin as little elevations of the inner surface, and grow into knobs, and globes, and glandiform masses, large enough to be seen, in a strong light, with the unaided eye. At a late stage, they are often impregnated with earthy salts, when they show concentric rings, which disappear with slight effervescence on adding dilute nitric acid. These colloid globes disturb the overlying epithelium; and by this irregularity of the choroidal surface, and by the size of the larger knobs, we ought to be able to recognise them in the living eye: indeed, in some cases, I have thought I could distinguish them, but in none of these have I yet had the opportunity of confirming my diagnosis by dissection. The affection is one of those degenerations common in old age, but which

also occurs in young persons as a sequel of long continued local inflammation.

The choroid is supplied with arterial blood by the short posterior and the anterior ciliary arteries. The former, about twenty in number, pierce the posterior segment of the sclerotic, some near the posterior pole, others further forwards. The hindermost are distributed to the sclera and choroid around the optic nerve; and, here inosculating with the capillaries of the nerve, they establish a collateral channel, through which a little blood can enter the retina when the trunk of the arteria centralis is plugged by an embolus. The remaining short posterior ciliary arteries run forwards with a straight course, sending off short branches through the stroma to the capillary net, where they break up quickly in an arborescent manner. The foremost of these arteries inosculate in front of the equator with the anterior ciliary arteries (branches of the muscular), which supply this region of the choroid. The capillaries form a net immediately at the outer surface of the elastic lamina, the meshes of which are smaller and less regular in the posterior segment of the choroid than in the anterior, where they are wider and longer. The vessels are large; and in all situations the interstices of the net are relatively narrow, less broad than the diameter of one of the overlying epithelial cells. We can recognise the collective effect of the

Fig. 5.

capillary net, but not the individual vessels composing it in the living eye. (Fig. 5.)

The blood of all the choroidal capillaries is collected by the well known venous whorls, vasa vorticosa, which empty their contents by four short wide trunks which pierce the sclerotic very obliquely a little behind the equator. The valvular form of these sclerotic canals has been noticed by Leber, who adds the remark, that it would tend to hinder the exit of the venous blood whenever there is an increased pressure on the inner surface of the eyeball.

The stroma in which all the larger arteries and veins are bedded is a modified connective substance. It contains, like that of the iris, branched pigmented corpuscles, which hang together in nets and membranes, and send off long and very fine elastic fibres. The thin layer of looser tissue external to the large vessels—the lamina fusca—has an essentially similar structure.

Besides the branched and irregular pigment-cells, the stroma always contains many pale, inconspicuous, roundly oval, and round cells and nuclei, of about the size of lymph-corpuscles, which increase considerably in number in inflammation, and which are, I think, the tissue out of which the formed elementary products of inflammation are evolved.

The nerves which we meet with in the choroid come from the ciliary ganglion; they lie quite on the outer surface, often in grooves in the inner surface of the sclerotic; and they all pass forwards to the plexus on the outer surface of the ciliary muscle. Whether any are distributed to the choroidal tissues, has not yet been made out with certainty; but

there is this in favour of it, that, in the posterior segment, very fine bundles of fibres, as well as single tubules, occur.

In both the choroid and in the ciliary plexus, pale as well as dark edged nerve-fibres occur. In both situations, ganglion-cells are present. These latter were, I think, discovered first by H. Müller and by Schweigger. Their demonstration is not always easy, or even a certain matter. Sometimes they are readily found; and, when one is perceived, others are usually soon brought into view near it; but fifty or a hundred preparations may be made without finding a single cell.

In front of the ora serrata, the inner surface of the choroid exhibits a circle of vascular plaits. First rising gently above the surface, and then projecting freely, these compose the pars striata of Zinn and the familiar ciliary processes. They are covered with a pigmented pavement-epithelium, the cells of which are less uniform than those of the posterior segment of the choroid. Each ciliary process is a vascular plait, composed of large capillaries, which receive their arterial blood by two or three branches, which come off directly by a short trunk from the circulus arteriosus major iridis, or which arise, nearly as often together with one of the arteries proceeding from the iris. The little arteries enter the outer surface (or rather edge) of the processes; and small veinlets run along the inner or free border; and they form a long meshed venous capillary plexus, which conveys the venous blood backwards to the vasa vorticosa. This venous capillary plexus not only transmits all the blood from the ciliary processes, but it also receives veins from the iris, as also some from the ciliary muscle.

To recapitulate briefly the distribution of the blood-vessels to the tunica uvea, its anterior segment, the iris, receives its arteries from the circle formed by the long post-ciliary arteries; and it sends its veins to join those of the ciliary processes and the vasa vorticosa. The ciliary processes receive their principal supply of arterial blood from the greater arterial circle of the iris, but derive some also from the anterior ciliary arteries. These last vessels also supply in part the ciliary muscle, which also receives branches from the great iritic circle, and sends veinlets to the circulus venosi. The posterior segment of the uvea is supplied by the short posterior ciliary arteries, and empties all its venous blood through the vasa vorticosa. These last vessels, therefore, transmit all the blood from the chorio-capillaris, that of the ciliary processes, that coming from the iris, and much of that from the ciliary muscle.

The large number of nuclei or masses of germinal matter in the stroma of the iris, and the abundant blood-supply, are circumstances which make inflammation of the tunica uvea one of the commonest of the internal inflammations of the eyeball. In iritis, the cell-growth is often so excessively active, that large accumulations of nascent granulation-tissue are formed. Such are the so-called beads of lymph, with whose appearance in the front of the iris every one present is familiar. They are not masses of exudation adhering to the anterior surface of the iris, but masses of young cell-tissue evolved in the substance of the iris—nodes, if you will, or minute gummy tumours, not differing essentially in their nature from a periosteal node or a subcutaneous gummy tubercle. I am not denying the occurrence of free exudations in iritis: such doubtless occur. One has only to harden an inflamed eyeball in chromic acid to find the iris coated, and the anterior chamber filled with an albuminous coagulum. We often see, too, in the living eye, in the course of iritis, flocculi floating in the aqueous humour, which are fibrillated fibrinous coagula. The yellow so-called pus in hypopion is also a free product of the iris. I have often examined it, and always found it a soft, but consistent, and not fluid mass, made up of a web of delicate fibrillæ and spherical corpuscles. In the posterior segment of the uvea, we also find inflammation producing alterations of the parenchyma, and exudation at the capillary surface. These last often upheave the retina, thrusting it towards the axis of the eyeball, at the expense of the vitreous humour. This may go on till the retina is quite stripped from the choroid, and coerced in the form of a pillar or slender funnel, fixed at the optic nerve entrance and at the ora retinæ. Often both forms, parenchymatous and serous inflammation, proceed simultaneously; and outgrowths of granulation-tissue project into the free space now existing between the choroid and the coerced retina. These are very liable to ossification; they are the seat of true bone-formation, which, I believe, never takes place in the normal ocular tissues. In this way, bony cups are formed around the optic nerve and rings of bone in the ciliary region—the two situations where ossifications are very commonly found. Generally, only a shell of bone is formed (the ossification, I think, always begins at the choroidal surface, and extends inwards); but sometimes the subretinal space is traversed by bony spicules; and these bases have been recorded as ossifications of the vitreous humour, the coerced retina being mistaken for the hyaloid canal.

The uvea is probably the seat of most ocular tumours occurring in

adult life; and these generally originate in its posterior segment, the iris enjoying remarkable immunity from these neoplasms. Indeed, the only primary tumours of the iris which have come under my personal observation have been congenital solid tumours, the histology of which is unknown to me, and cysts of which I have now seen several, and examined a few. They are evolved in the iris, and bulge into the anterior chamber, as also to a less extent backwards; and they consist of a delicate hyaloid membrane, lined by a very beautiful pavement-epithelium.

The tumours which are most common in the posterior segment of the uvea are sarcomata and cancers. I am inclined to think that the majority are sarcomas. I employ these terms with a strict anatomical definition, and without reference to their clinical history. Sarcomas are histioid; cancers organoid in their fine structure; and the former may, and often do, exhibit clinical features of the most malignant type. Both begin in the choroidal stroma; they often seem to split the choroid, and bulge inwards, displacing the retina, and wasting the corpus vitreum.

THE MODE OF ADMISSION OF PATIENTS INTO BRITISH HOSPITALS.*

By T. P. HESLOP, M.D.,

Physician to the Queen's and Children's Hospitals, Birmingham.

THE notion that rather generally prevails, both among the general public and members of the medical profession, as regards the utility of our hospitals, would be considerably modified were their administration better understood. There can be no doubt that much good springs from the worst governed of these institutions; but the existence of this good is purchased in the worst possible manner—in a manner which combines all that is repulsive to science and humanity—while it is essentially based on an appeal to the meanest part of our nature. That an institution for the relief of the sick poor should be set up and maintained on the principle that those rich men who give of their superfluity towards its support should dictate as to who should be admitted to, and who should be withheld from, its benefits, is an affront to medical science, and an outrage on charity and religion. I feel that this bare statement of the case, without fact or argument, should be sufficient to ensure the hearty concurrence of the Association in the statement, that the system by which patients are admitted to the benefits of the great majority of English hospitals is a vicious system, and ought to be abolished. Let me, however, detain you for a few minutes, while I ask—What is the aim of these charities? What do they profess to accomplish? How far do they succeed in effecting their object?

The aim of hospitals proper is to provide lodging, maintenance, medical appliances, and the advice of skilled physicians and surgeons, for persons who are either affected with such dangerous maladies as to require special skill, both in the medical attendance and in the nursing; or, who are in such a position of life as to require charitable assistance, even if their disorder be of an ordinary character. The latter category includes individuals who are more or less temporarily placed in difficulties from sickness, bad time of trade, nature of the season, or from moral causes, such as drunkenness. Let it be observed, however, that it excludes all those who, either from age, chronic nature of malady, physical or mental incapacity, or want of work, are thrown out of the possibility of effecting self-maintenance, and thus become fit subjects for the care of Government in those countries, like ours, where the absolutely destitute become emphatically children of the State. The only exception to the excluding influences of such cases as these, is to be found in my first category. Should a pauper become the subject of a dangerous disorder, requiring special skill for its treatment, he then becomes a fit object of private charity. He rightly applies at the door of the renowned hospital, though it may have been opened by the contributions of private benevolence. This exception is by no means universally entertained. It is believed by some that the fact of hospitals, so maintained, undertaking the care of these unhappy persons under such circumstances, tends to put off a just administration of the Poor-law system, and to blind the Government to the inefficiency of our workhouse medical service. It may be so; but I have ever held, both in practice and in writing, that we, knowing the deficiencies of that service, are bound to serve paupers in their extremity, at the expense of voluntary charity, until the conscience of the governing classes shall be awakened to a higher sense of duty.

My first division needs but slight explanation. There are many per-

sons fully competent to remunerate a private practitioner, who are very far from being able to pay the ordinary fees of eminent consulting practitioners. If such an one suffer from stone in the bladder, cataract, ovarian disease, hydatids of the liver, and such like, he or she needs a skilled opinion, a hand made dexterous by experience, and a nurse who has other faculties than those of drinking and sleeping. There can be no doubt that persons so circumstanced are, in the completest sense, fit persons for the reception of hospital relief. I believe that founders have had these specially in view when endowing medical charities; for how else than through them can those deserving and honest people, neither rich nor very poor, who become afflicted with formidable maladies or accidents, obtain the service of the chiefs of the profession? Here I make no exception. As I repudiated the inhumanity which would exclude the pauper from hospitals even when suffering from conditions for which no adequate provision has been made in our Poor-law system, so do I refuse to take part or lot with those who, in obedience to a selfishness which is only professional in name, clamorously demand the exclusion of all who can in any manner recompense any medical man whatever for his services. I shall not speak of the want of modesty of such a view; I prefer to declare that it is opposed to the best traditions of medicine.

That which hospitals do in fact more or less explicitly profess to accomplish is as follows. They profess to be open at all times to the sick and hurt; to offer an asylum wherein protection and skilled treatment may be found; to ensure to the hospital population, as above defined, an amount of comfort and a range of scientific knowledge which, but for such institutions, would be totally beyond the power of that population to obtain, and, by consequence, would become the particular privilege of the rich.

The monks, both of the east and west, in past times; the Governments of continental Europe; the founders of some of the Scotch infirmaries in our own times, have endeavoured to extend this particular privilege of the rich to all people possessing the rightful claims derived from suffering and small means. Disease has been held to level all distinctions; and, under the guiding hand and voice of charity, science has lavished her choicest treasures on tens of thousands of poor creatures who would otherwise have only known enough of those treasures to lament the lot that placed them beyond their reach.

In England, a state of things exists which renders it impossible that hospitals can fulfil the object for which they were established. I have known and openly asserted this, in various ways, for many years past; but those to whom the subject is new will find all needful information in the sixth Report of the Medical Officer of the Privy Council. It contains the elaborate, but far too little known, Report of Dr. Bristowe and Mr. Holmes on the hospitals of the United Kingdom. There the hospital system of England is to be found depicted in its true colours by impartial observers; there are the proofs that so far are our hospitals from carrying out the aim for which they exist, they uniformly, though in different degrees, fail to perform the good they profess to accomplish. I will give the substance, and, as far as possible, the very words of their conclusions on this subject. In London, as contrasted with Paris, hospitals are private institutions, and receive only such cases as the governors of the hospitals choose to admit. Such rules as are approved by the governing body fix what cases each hospital shall receive, and these regulations differ for each. Most of them exclude fever and measles. Several exclude, by rule, all cases of fever. The number of beds is also fixed solely according to the salubrity or convenience of the hospital, and not at all by the wants of the district. The beds are allotted to medicine and surgery in proportions quite different from those in which such cases occur in actual practice. In the great majority of London hospitals, which depend entirely, or almost entirely, on private bounty, it has been found necessary, in order to conciliate the subscribers, to allow them a kind of right of nominating the recipients of their charity. A larger or smaller proportion, according to circumstances, are received from considerations of urgency; that is to say, for purely medical reasons; but the bulk of the patients are received, partly on account of the gravity of the disease, and partly because they bring a subscriber's letter; that is to say, partly for private reasons.

In English country hospitals, properly so called, no proportion is kept between the number of the beds and the wants of the district. All cases of infectious disease are in most cases excluded—a regulation which involves the exclusion of almost all acute medical cases. The right of the subscribers to nominate the inmates of the hospital is far more rigidly enforced than in London: the proportion of accidents and urgent cases admitted without such nomination is smaller. These establishments are practically reduced to the treatment of accidents and cases of chronic disease. At the Radcliffe Infirmary, in this city, in 1862, out of 896 patients admitted, only 10 medical cases were taken in

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