But in addition to a chemical and thermal change taking place when a muscle contracts, there is a remarkable one of an electric character, which is supposed to be intimately connected with the irritability of the muscle, for it is found that these muscle currents, as they are called, diminish and disappear as the irritability of the muscle declines.

Some years ago I removed a portion of a needle which had been embedded in a woman's finger upwards of two years. This piece of needle, which is still in my possession, was found to be, and still remains, unattracted by an ordinary magnet, but easily attracted by a piece of steel, showing that it has become magnetic. Was it in some way rendered magnetic through the agency of these electric muscle currents in the living body?

In regard to the setting free of energy by muscular contraction, it may be stated broadly that the amount of contraction may be taken as a measure of the strength and amount of nervous impulse inducing it, but that no difference can be detected between the nature of an impulse originating spontaneously in the central nervous system, and one excited by electric currents or mechanical stimuli.

Another fact worthy of note is that a muscle is excited to increased action by increasing the work it has to do. Thus if a muscle raised a given weight to a certain height it would be naturally thought that, if the weight were doubled, it would raise it to only half that height, but this is not so. It is supposed that the stimulus of the increased weight leads to a more perfect explosion of the inogen in the muscle. Of course this is within limits, for it is obvious that there must be a point when no stimulus, however great, would enable the muscle to raise the increased load at all. And this remark is applicable to the heart as a muscle, for a full ventricle will contract more vigorously than one not so full, but an over-distended ventricle may cease to beat altogether.

As evidencing the independent irritability or sensitiveness of muscle, it may be observed that when the sciatic nerve is divided its irritability, owing to degenerative changes, soon disappears, but as long as six or seven weeks afterwards there may be muscular hypersensitiveness, although the muscle may have lost all its connection with the nerve. Now muscular fibre, as a rule, responds like a nerve to an electric current, but it is more sluggish than nerve, and requires to be acted upon for a longer time, so that a constant current will induce contractions in a muscle deprived of its nerve connection when a transient induction shock will not. The condition of nerves supplying a muscle may be determined in medical practice by this test, inasmuch as if they have not lost their irritability the muscle as a whole will respond to single induction shocks, but if they have lost it the muscle will not so respond, although it may be easily thrown into contraction by the constant current.

Blood supply is an important factor in maintaining irritability of both muscles and nerves. When the abdominal aorta is ligatured the muscles of the lower limbs lose their irritability and become rigid. So when the circulation ceases, as at death, the same event follows in all the muscles of the body, although it should be noted that rigor mortis occurs in a fixed order, beginning in the jaw and neck first, then in the muscles of the trunk, then the arms, and lastly the legs.

The sense of fatigue after prolonged exertion seems, as I have before remarked, to be referable to the nervous system, and, after the greatest exhaustion of the muscles, recovery takes place on rest. Perhaps nothing more rapidly produces muscular exhaustion than tetanus, and I have a distinct recollection of a case of traumatic tetanus in a young man where violent contractions were induced by touching the wound with a probe, but, after a short time, exhaustion would supervene, when further excitement ceased to have any effect, and yet, on waiting some minutes, the spasm could be reproduced by the same stimulus.

Again, in contractions during labour, the uterus requires intervals of rest, and it is of common occurrence for a stronger pain than usual to follow a longer than usual interval of rest. Whether, in cases of temporary exhaustion, the effect is produced by all the contractile material being used up, or by the accumulation of waste products in the tissues, or by both causes, may be open to conjecture.

Many other points of interest connected with the muscles must be passed over. As regards the nervous system proper

such a wide field is opened up by it, and the remarks I had prepared in reference to it would occupy so much space that I am reluctantly compelled to defer the consideration of them altogether to some future opportunity.

ON MINERS' NYSTAGMUS.

By SIMEON SNELL,

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AFTER reading my paper before the Ophthalmological Society, in 1884, on Miners' Nystagmus, I wrote in the pages of the BRITISH MEDICAL JOURNAL a letter, in which I earnestly solicited information from medical men attached to coal pits, and from others who might be interested in the affection, which would tend to elicit the truth whether it supported my observations or not. I concluded by saying: "My desire for facts is not merely to support the views I have expressed, but to arrive at the truth."

I have since availed myself of every opportunity to gather information which would aid in elucidating this, to me, most interesting malady. The result of all my investigations has been to corroborate in the fullest manner the observations I have previously published. It is my purpose in this article to set forth evidence in support of my contention that the prime cause of miners' nystagmus is to be found in the constrained attitude a certain proportion of the workers in a coal pit are compelled to assume at their work, and to show also how the question of safety lamps and illumination can only occupy a secondary position.

My conclusions are derived from an experience of more than 500 colliers, who have at different times been under my care for nystagmus, and I have records of 120 cases with which I propose specially dealing in this paper. Many points of interest and importance will have to be omitted, or mentioned very briefly, for want of space.

For the proper understanding of the subject a knowledge of the working of a coal mine is almost necessary; but, for its thorough investigation, it may be safely asserted that an intimate acquaintance with the detailed working of a pit and the different ways which men are employed underground is of the first importance. With this end in view, I have not only obtained the assistance of Government mine inspectors, managers, and other officials, as well as the kindly help of many colliers themselves, but I have been down into the coal pits, seen the men at their work, and have by all these means become familiar with the interior of the mine and the various kinds of work in which the men are engaged.

The nature of the peculiar oscillations of miners' nystagmus I have previously described.¹ The ocular movements of a to and fro, and rotatory character are associated with apparent motions of objects, and the manner in which the collier so affected sees his lamp dance or spin round, has, I think, a great deal to do with his impression that the "safety lamps" are the cause of his malady. The worker with candles also makes a similar complaint as to the motions of his lights.

The original Davy lamp consisted of a cylinder of wire gauze encircling a light whose illuminating power was considerably below one-fifth of a standard candle. Dr. Clanny introduced the use of glass for the lower part in place of the gauze, and these lamps have been used for many years. Further advances in the illuminating powers of safety lamps have also been made, and the Royal Commissioners on Accidents in Mines, who reported in 1886, speak favourably of the Marsaut lamp. This lamp is one of the four recommended by the Royal Commission, and is largely employed in the Midland district. Such a lamp gives two-thirds of the light of a standard candle, and three times and a half the light of a Davy. In the modern safety lamp the gauze is bonneted by a sheet-iron casing, which not only protects it from strong currents of air, but causes the flame to burn with a steadier and more uniform light. I know the miners object to the shadow cast by the bonnet, among other things, of the safety lamp; but

¹ *Ophth. Soc. Trans.*, 1884.

as a miner, who had one time worked with a Davy lamp, speaking of a modern lamp, said very pithily, "It is daylight to the old one."

The alternative to the use of safety lamps in a coal pit is the employment of naked lights. In some places open oil lamps—"torches," as they are called—are in use; but when safety lamps are not employed, the illumination is generally effected by candles: for ordinary work these tallow candles are from sixteen to twenty to the pound. In the Derbyshire collieries the candles mostly used are eighteen to the pound; they are thin and long, and have a thick wick. The candle is fixed in soft clay, which makes it easy of attachment to the place where it best throws a light on the work. The influences of currents of air on the unprotected candle will be apparent, and in strong currents it becomes necessary for the light to be shielded either by a prop or other protection, and the quantity of diffused light is materially diminished.

A miner naturally, I think, prefers a candle. I have seen them both used in a mine. The candle is easier to handle, can be stuck in almost any position, and exposes a naked flame with a more diffused light. Many persons, however, have an erroneous idea of the comparative light-giving power of a safety lamp, and are apt to suppose that it refers to such candles as the miner uses, whereas the comparison is to the light emitted by a standard candle.

Through the kindness of a friend I have been able to obtain an analysis, by an expert, of miners' candles which were submitted to him. All I can do here is to say that no two burnt with regularity or similarity, that candles 18 to the pound emitted light varying from 36.80 to 73.60 per cent. of the standard candle; and candles 16 to the pound 61.53 to 77.24 per cent. of the light of the standard candle. It was only by snuffing and nursing the thick end of a 16 to the pound candle that a light was obtained exceeding that of the standard.

It has been asserted that nystagmus is now more common than it was formerly. I am not aware of any statistical information on the subject. As far as my personal experience goes I certainly meet with more cases. This is not to be wondered at considering it is well known that I have paid special attention to the subject. I am not aware, however, that these miners' cases have increased in any very undue proportion to the greater number of eye patients which come under my notice. A knowledge of the disease, however, has become more diffused among medical men. It is important also to remember the large increase in the numbers working underground. In 1860 there were 300,000, and in 1890, 506,812.

The advocates of the safety lamp theory, in insisting on the greater prevalence of nystagmus, appear to overlook the improved illuminating power of modern protected lights. An increase under these circumstances is rather an argument against the prominent place it is asserted that safety lamps occupy in the causation of the malady. As long as I have been acquainted with nystagmus I have been equally familiar with the opinion of the collier that it is "all the lamps." There is a rooted prejudice, which sometimes is a hindrance to properly investigating a case; but, on the other hand, I have seldom failed to convince a miner coming for treatment that there was a more potent cause at work than the mere employment of his safety lamp.

It is often alleged by the advocates of the safety lamp theory that men suffering from nystagmus become improved when they leave a pit where safety lamps are used and obtain employment in a mine worked by naked lights. In view of the fact—which I shall be able to establish—that nystagmus is by no means infrequently met with in candle-lighted pits such a statement is not of much moment. Several times the tale has been reversed. Men working in safety lamp pits have become worse on going elsewhere where naked lights were used, and others have failed to improve. The statement is frequently made, however, and therefore it may be well to analyse it somewhat. The essential thing is to be clear that the work pursued under the two varieties of illumination is as nearly identical as possible. This is of vital importance. A change of work would also have been beneficial in a safety lamp pit. Reference will be made further on to the fact, borne out by several cases, that a man who has suffered from nystagmus may continue his work in the pit as long as he discontinues the kind of employment which I shall show to be acting so prominently in causing this affection.

I have investigated cases of alleged improvement by simply changing from one pit to another, or from safety lamps to naked lights. Last year a collier, the subject of well-marked nystagmus, told me that his brother had suffered, had gone to work in a "candle pit," and had got better. It turned out on investigation that formerly he had been a stall man doing "holing"—work prejudicial, as will be presently shown. I went down into the pit, saw this man at his work, and now, as expected, it was different; crooked down on his haunches, with head upright, he was able to use his pick more directly forwards; he was, in fact, engaged at work which I should have permitted him to have done in a safety-lamp pit. No such cases of alleged improvement can be accepted unless the evidence is clear and distinct of a continuance of employment similar with naked lights to that followed when using safety lamps.

I come now to deal with the presence of nystagmus in men employing naked lights. The following interesting instance is among my cases:—

G. H. came to the Sheffield General Infirmary on November 25th, 1890. He was suffering from particularly well-marked nystagmus, and had been compelled to leave his work. His age was 38; he had been employed in coal pits for twenty-four years. At first he worked with candles, then for fourteen years together with safety lamps. During that time he experienced no ocular discomfort. For the last three years and a half he had been working in another pit, with candles and not lamps. His work had been the same as it was when using safety lamps. He had been a coal getter; to use his own words, he would "drive a heading and get the coal down by holing three or four feet under"—that is, undercutting the seam of coal. He dates the earliest symptoms back fifteen or eighteen months, or, in other words, not until he had ceased the use of safety lamps and been employing candles for more than two years. He continued his work, however, until four days before first coming to me, when he was compelled to desist. There is thus no doubt in this case about the nystagmus developing during the time he used candles.

In the districts around Sheffield safety lamps are very generally used. The pits in which candles or naked lights are employed are generally small ones, and the number of colliers engaged is small. The proportion also of the naked-light miners to the general body of colliers in this district is a low one. One of my cases, a youth, developed symptoms of nystagmus after working with "torches." He had previously worked with safety lamps without discomfort; but after three months with a "torch" he developed the characteristic dancing of lights and sought my advice. I pass by without mentioning other instances to give a brief account of a most interesting series of cases, which were employed at a Derbyshire naked-light colliery. The man to be first mentioned having paid me a visit, promised if I would go over, to get together other men whom he knew to be suffering from nystagmus. This he did at very short notice, and the cases were examined by me in company with Mr. Hayes and another medical friend.

A man, aged 31, had worked in the pit since the age of 6. He was a stallman, doing holing and other work. This man had never used safety lamps. He had suffered from symptoms for eighteen months, and had been away from work on and off a great deal during the last twelve months, and had not worked for five weeks at the time when first seen by me. Including this man there were six at this time off work from his pit (in which the number employed was 350) in consequence of nystagmus. They were mostly well-marked cases. One had never used safety lamps; another had only worked with them for six months five years ago; a third had only used "lamps" for twelve months seven years ago, and he had worked in a pit for thirty-nine years; another had been engaged in a coal pit for forty-six years, and, except for an occasional day when there was gas about in the pit, he had never worked with safety lamps. The same remark applies to another who had worked for thirty-seven years in a pit, and the sixth had never used "safeties" at all. With one exception all were stallmen, getting coal and doing holing; that is, out of a total of 150 stallmen, five were off their work in consequence of nystagmus, and were examined by me. The sixth was a loader, also, however, doing coal getting.

Six other cases were also seen by me. One had been employed in a pit for fourteen years. He had always used candles except two years ago, when he employed lamps for three months, and also for an occasional day when gas was about the workings. He was off work in consequence of nystagmus, and had been so for a week. Another man had worked in a pit for twenty-one years. He had never been obliged to leave his work, always used candles except for eighteen months, when he worked with safety lamps. This period ceased eighteen months ago, and it was clearly shown that it was not until he had returned to the use of candles for three months that he felt any discomfort as to his eyes.

Another man, aged 45, had just returned to his work. He had suffered on and off for sixteen years; he had worked in a pit for thirty-two years; for twenty-seven or twenty-eight years of this time he had used candles, but at different periods he had used lamps, the longest term for three years. He was a decided partisan as to the injury from lamps, and I found it impossible to say with the use of which mode of illumination his symptoms commenced. One thing, however, was quite clear—that with naked lights he was no better, for he had just returned to work after an absence of three weeks.

Another man worked at first with naked paraffin lamps, then for four years with safety lamps, and for the last fifteen months with candles. As far as I could gather, his symptoms commenced when using the safety lamps. He was still employed, and I do not think he had at any time left his work for nystagmus. The ocular movements were well marked, and work in the candle pit had clearly not improved him.

Another man who was present was employed in a safety lamp pit. He had worked fifteen years with candles, and later with safety lamps for ten years. His symptoms were quite recent, but he had not left work.

A twelfth case was seen at this visit. He was a "deputy," and reference will be made to this interesting case further on. He worked in a candle pit but employed a safety lamp, as his work was to examine the workings for gas before the men entered the pit.

I had another opportunity, in company with my friend Dr. Cocking, of examining most of these men; in fact, some I saw on three occasions. I saw, also, two other cases. One was a "deputy" similar to the other already mentioned; the second was a man aged 28, who had worked in a pit for eleven years. Up to twelve months ago he used safety lamps, since then he had been working with candles. The symptoms appear to have commenced about the time of ceasing the use of safety lamps; he has, however, been getting worse since using candles. Besides these cases I found that the occurrence of nystagmus was well known among these men in candle-light pits. A father had a son afflicted, and a son a father; and further definite evidence was given me of the existence of several other cases which these men knew of, and which would have been gathered together for my inspection had circumstances permitted.

The information gained by this investigation is most valuable, and its bearing on the relation of safety lamps to the affection most important. Eleven cases were found among the candle men. Some had never used safety lamps at all, and the keenest advocate for the theory attributing the malady to their use could, in those other cases in which the use had been so little and so very occasional, hardly venture to suggest that they in any way owed their nystagmus to this cause. In the judgment of most it will be, I think, evident that the existence of such cases as I have mentioned absolutely prevents the acceptance of the employment of safety lamps as a prime cause, and they demonstrate clearly that nystagmus does occur, and that frequently, in circumstances where such a cause is wanting.

Further evidence is furnished by the two cases to which reference is now made. For the present it is merely necessary to say that they were not practical colliers, but were engaged at the bottom of the shaft as "onsetters" attending to despatching to the surface the tubs of coal. Now, anyone familiar with a coal pit knows that the bottom of the shaft is well lighted. In some collieries the electric light is employed, in others gas. In one instance large oil lamps were used; and in the other, as the patient said, "there is plenty of light from big paraffin lamps."

Here, again, nystagmus is found in circumstances in which

the illumination can hardly be found fault with. A medical friend informs me of another similar case, but I have not yet seen the man.

In this connection may be mentioned the case of a young compositor working under ordinary illumination (gas), who developed nystagmus, vertical in character, the causation of which can, in my opinion, be traced to his work (see page 74).

I have now, I think, advanced evidence proving not only the existence of nystagmus in the miners employed in naked-light pits, but also in circumstances in which the illumination can hardly be found fault with, and rendering it impossible for the employment of safety lamps to be regarded as the prime cause. My object has been to demonstrate the existence of nystagmus in men employing naked lights. It is on this point my views have been assailed, and I have given proofs for my opinion as to its occurrence under the circumstances named. I am not now concerned with the greater or less frequency of nystagmus in pits using safety lamps or naked lights. I have, in allowing imperfect illumination a secondary place, deemed it not unlikely that, other things being equal, the disease would be more frequent under the worse conditions as to light. I am bound to say, however, that the relatively large number I found off work at the naked-light colliery was more than I was prepared for.

We must now pass on to consider in what way the nystagmus of miners is produced. I have no doubt the prime cause of nystagmus must be traced to the peculiar circumstances under which a collier's work is accomplished. As long ago as 1875² I drew attention to this, and stated that "it seems to me this disease occurs chiefly, if not entirely, in those colliers who are obliged to do their work in the pit whilst lying on one of their sides." In a paper before the Ophthalmological Society in 1884 I further elaborated this contention of the relation of position at work in causing the disease. All tended to show that nystagmus was associated with a particular class of colliers performing a particular kind of work. The kind of work alluded to is called "holing." Among other evidence advanced in the paper mentioned was an account of a visit to a coal pit made by me to verify, by actual observation of the men at work, the impressions gleaned from clinical experience. To put it briefly, the men whom one expected to find suffering from nystagmus were so afflicted, whilst others pursuing different kinds of work were unaffected. My further observations will be found to support the views I have previously set forth. Further experience and a better acquaintance with the working of coal mines have shown me that in others besides those "working on their sides" (holing) an attitude is assumed necessitating a somewhat similar position of head and eyes, and cases will be mentioned in which nystagmus has occurred in men so employed.

The workers in a pit are of various kinds. Thus there are labourers (datalers), whose employment is to attend to the roads, to keep them in repair, etc.; trammers or haulage men, who push the tubs or corves, full or empty, along the rails; there are also drivers or pony boys. Now all these men in pits, where protected lights are used, employ safety lamps, and thus work under similar conditions of illumination to others employed underground; yet it is not among these that nystagmus is found. Such is my opinion, and it is amply corroborated by others.

Dr. Tatham Thompson,³ speaking of the South Wales collieries, mentions the "absence of nystagmus among the labourers and hauliers." Mr. Jeaffreson, of Newcastle,⁴ also says "it is equally certain that it is amongst this class (colliers) confined to those that hew coal." Nieden, after examining the large number which he did, found nystagmus confined to the hewers. Dransart is of a similar opinion.

The men employed in a pit who generally receive the name of colliers or miners are those engaged in coal-getting; on their labour all the others engaged depend. At the coal face we shall find men engaged in coal-getting and others employed in filling the corves or tubs with the dislodged coal; these latter are called "fillers" or "loaders;" they are usually paid by the day, and if there are no corves to fill they not uncommonly lend their aid to the coal getters. Nystagmus is exceptionally met with in these "fillers."

² *Lancet*, 1875, vol. ii, p. 81.

³ *Lancet*, vol. i, p. 311, 1891.

⁴ *BRITISH MEDICAL JOURNAL*, 1887, vol. ii, 109.

The man engaged in winning the coal and the manner in which his work is accomplished possesses the most interest for us. His business is to detach the coal from the coal seam generally by holing underneath the seam. To do this he has to work in a peculiar position. He sits down with his legs crooked up, lying almost on his side, and strikes with his pick at the bottom of the coal, his object being to undermine or undercut the seam. He will clear away the coal thus to a height of 18 inches or 2 feet, and then, as he gets deeper in, he gets his body under the coal, lying on one or other of his sides. The distance he may undercut the coal varies considerably. The process is called "holing," and sometimes he may undermine the seam of coal for 2 or 3 feet to as much as 6 or 7 feet; this is called "bottom holing." There are besides this, however, two other varieties. "Middle holing" is carried on in the middle of a seam, just where shale or friable coal may occur; "top holing," as the name suggests, is done at the top of the seam. In all these varieties the pick is swung to and fro in a horizontal line. The coal is afterwards detached by wedges, or in some pits by explosives. Other men may be engaged in what is called "cutting the headings." This work will be done directly forwards with the pick swinging in a vertical line; the man will generally be kneeling or crooked down when he does it, but with the head straight; these men are not, I think, liable to nystagmus.

When holing is necessary, about 30 per cent. of the work at the coal face is holing, being equivalent to about 20 per cent. of the work underground.

I will now advance evidence showing the intimate relation of holing to miners' nystagmus. In 1883 I visited a large well-ventilated pit in which several hundreds of men were engaged underground. I have described this visit in detail in my paper before the Ophthalmological Society in 1884. I was taken to the coal getters. Three sets of these were examined: (a) Those who were engaged in "cutting the headings," working with the pick directly forwards in the manner already described. In none of these men was nystagmus found. (b) Then I was taken to those engaged in holing or undercutting the coal, and four of the six men working at the places I went to suffered from nystagmus. The two who were unaffected were young men. These were the particular class expected to be afflicted. (c) Trammers and men otherwise engaged in the pit were examined, and nystagmus was not found among them.

My visit showed me the importance in investigating this question of a personal acquaintance with the interior of a pit. Such a visit goes far to convince one also that the position assumed by the miner must be an important factor in the causation of nystagmus. Dransart is of opinion that one visit is enough to comprehend the part played by work at the vein.

I have made a calculation that at one time or another more than 500 cases must have passed under my notice for treatment. I lay particular stress upon this, for my clinical results are based on cases that have sought me—a very different thing from cases which one has sought out himself. I have made no calculation of, and do not now take into account, a considerable number that I have casually noticed. At the time I commenced this article 14 cases were on my books at the Sheffield General Infirmary. For our purposes now I have collected together all the records preserved of cases. Some are under date several years back and others, the majority, are recent, within the last year or eighteen months, and they vary much in completeness. The number of which I can get records is 120. All of these have been under treatment except 14, which, as already mentioned, were examined when investigating the workers with naked lights.

Taking now the 120 cases, and analysing the work performed by them, I find 112 were coal getters and doing "holing" more or less, 3 (there was also a loader included in the naked light series) were "fillers," which should be added to the first group, because, as I shall show, though not regular holers or coal getters, men of this class do work of this kind; two were "deputies," two were "onsetters" at the pit bottom and one was an "engine man," a term which as will be seen presently very imperfectly describes his work. My experience teaches me that the summary as given above would be true also of the cases of which I have preserved no records;

besides those mentioned, I do not recollect any other exceptional cases.

Before considering some of these cases in detail it may be well to say a few words on the method to be pursued in investigating the kind of work performed by a miner suffering from nystagmus.

For years it has been my practice to avoid leading questions as to the kind of work pursued and to get the patient himself to demonstrate as much as possible his attitude at his work, the man going down on the floor and illustrating his mode of work; in a doubtful case he has always to put himself in the attitude he would assume at his occupation. By adopting this method I have not only gone to the bottom of my cases as far as the kind of work pursued is concerned, but I have ascertained that in other kinds of work in the pit a position of the head and eyes is also assumed, which no doubt acts as prejudicially as does the constrained position in holing. Thus I learnt that a man suffering from nystagmus, who was a "holer," did also work which he called "clodding," that is, clearing the clod or rubbish off the top of the coal. It is a position not unlike "top holing." I had a photograph taken as he represented himself at this work. His height was 5 feet 9 inches, and he worked under 5 feet, and he did so as upright as possible with his head on one side.

The association of nystagmus with the particular kind of workers which my cases have demonstrated has not escaped the notice of others. Dransart, whose painstaking observations in this affection are well known, alludes in a foot-note attached to his paper in the *Annales d'Oculistique*, 1877, vol. ii, p. 121, to the man working in the shallow inclines constantly lying, and adds: "We ought to note this fact that all our workers attacked with nystagmus worked in these inclined bearings."

More recently Zieminski,³ who "has made a special study of nystagmus in England, attributes this muscular anomaly to the constrained attitude of the work of the miners, their look being forced to direct itself obliquely above either to the right or to the left."

In my paper before the Ophthalmological Society I quoted Neiden as assigning the cause of nystagmus to the use of "safety lamps." He kindly wrote pointing out that I had not quite correctly interpreted his views, as he had also found nystagmus in pits where the ordinary lamps were used. He said further: "In all my papers about nystagmus I stated as the *first, prime*, cause of this affection the particular kind of work which the *hewers* had to do in holing the coal in a stretched position of the body, head and eyes."⁶

The pathology of miners' nystagmus is similar, I believe, to writers', pianists' or telegraphists' cramp. It is a local affection, and is the result of prolonged strain in an unusual and constrained position, chronic fatigue results, and atony of the muscles being induced, oscillation of the globes is caused.

Dransart⁷ held that the disorder was due to the fatigue induced in the elevator muscles in consequence of the cramped position of the miner occasioning strain and a constant upward movement of the eyes. I have elsewhere⁸ fully discussed these views.

If we now consider the position of the miner engaged in "holing" we shall, I think, conclude that the position is not sufficiently described "as the constant upward movement of the eyes." There is something more, and whilst Dransart's⁷ explanation accounts for many of the symptoms present, it hardly meets the rotatory movements which are seldom absent.

The constrained position of the miner in holing has been already mentioned. It is work common not only in this country but on the Continent. The French name—*travail à col tordu*—expresses its cramped nature. A man lying on his side engaged in "holing" either whilst making the hole or whilst continuing his work under the coal, will of course fix his gaze at different parts according to where it is necessary to

³ Analysed in *Rec. d'Opht.*, 1889, p. 637.

⁶ The italics represent underlined words in the original.

⁷ *Annales d'Oculistique*, 1877, vol. ii, p. 128; 1882, vol. ii, p. 150.

⁸ *Ophth. Soc. Trans.*, 1884.

⁹ In a recent paper before the French Ophthalmological Congress (*Rec. d'Opht.*, May, 1891) Dransart speaks of "the upward and oblique gaze" of the miner. Out of 179 cases of nystagmus he says 92 used safety lamps and 87 naked lights.

strike, for his eyes will follow his pick point, but the tendency will be for the gaze to be directed more or less obliquely. I have satisfied myself on this point times without number. The miner will lie on his side, sometimes the left, sometimes the right, as is most convenient; his legs will be crooked up, his head thrown back and flexed more or less on the shoulder beneath, and the eyes will have the direction as just mentioned.

The physiology of the ocular movements supports my contention, because when we incline the head to one side or the other by turning it on its antero-posterior axis,¹⁰ rotation of the two eyes upon their antero-posterior axes takes place probably by the instrumentality of the oblique muscles.

A miner working on his left side will be using in the left eye the superior rectus, inferior oblique, and internal rectus; and in the right the same two first named muscles, but substituting the external for the internal rectus. If he be on the opposite side the arrangement will be reversed. The to-and-fro movements met with in nystagmus are thus accounted for by the weariness of the outer and inner recti, the rotatory by the inferior oblique, and the superior rectus aids here or in occasioning the vertical movements.

Before leaving this portion of my subject, I may mention as worthy of note the ready manner in which discomfort is occasioned and nystagmus rendered evident, even in cases that have improved by rest or change of work, by assuming before one the position required in holing. Also the oscillations become perceptible on directing the eyes upwards¹¹ and particularly obliquely upwards, when otherwise they would be less evident or pass unnoticed. Some men are accustomed to do their work with one side down more than the other, and not infrequently the oscillations are more marked on looking to one side, and it is often possible thus to tell the patient on which side he is most accustomed to work. I find 10 such cases in my record, but the condition was not always looked for.

Among the 115 cases that I have classified under the name of doing holing are included three "fillers." These at first sight might appear as exceptions. Nystagmus is infrequently met with in fillers or loaders, and these are the only instances I recollect at any time coming under my observation. A filler's work is to fill the corves or tubs with coal. He, however, aspires to be a collier, and is not unwilling to lend a hand at coal getting—in fact, when he has no tubs to fill he is expected to do so. One of these cases in particular I very carefully inquired into, and went some distance, in company with Mr. Wightman, assistant house-surgeon at the Infirmary, to interview the men with whom the young man worked, and learnt that he never passed a day without holing. As to the others I also satisfied myself.

For many years I have been on the look-out for exceptional cases. I have asked my friends in colliery districts to send me any they might observe. The five to be mentioned now are the only ones I have notes of or recollect. Of these, two were "deputies." Until quite recently I had not seen cases from this class of pitmen; it is, however, easy enough to understand why they should suffer. I found both instances when examining cases from a naked-light pit. The duty of a deputy is to enter the pit and examine the workings for the presence of gas before the men go to their work. He has also to ascertain carefully the condition of the roof. They are selected for this post for their steadiness and intelligence. I will give particulars briefly of one of these cases:—

C. W., aged 32, has worked in a pit twenty-two years. He has worked at coal-getting and holing, but for the last eight years he has been a "deputy." He previously used candles, but, though still working in a candle-light pit, it is necessary for him to employ a "safety lamp" for detecting gas, etc. He works a nine hours' shift; that is, he is in the pit at work for eight hours. For about four continuous hours he is in the working places from 4 feet to 6 feet examining the roof. On finding out that he was suffering from nystagmus and learning he was a deputy, I at once asked him to put himself in the position for examining the roof. He placed himself with head on one side, and eyes directed upwards and obliquely, as expected. There were several colliers in the room, and they agreed as to the correctness of the position he assumed.

I have since had his photograph taken, and obtained the agreement of a fellow deputy and several of his fellow workmen to the correctness of the picture. He is a man of about 5 feet 7 inches in height, and in the photograph he is represented in the position assumed by him for examining the roof under 5 feet. It must be recollected that in the pit his head must be on one side, and if he raises it he will strike it against the roof. His symptoms date back to about twelve months, and for five weeks in the autumn he was off work. The oscillations were well marked. He finds stooping and looking up makes his eyes bad, and he tries to keep them directed downwards as much as possible.

The second patient had also used naked lights until he became a deputy; he has had symptoms for two years.

Both these men, it will be noticed, had previously been engaged in "coal-getting and holing" and using naked lights. There is no evidence of their having suffered during this period from nystagmus, and I accept the cases as developing the malady during the time they have been deputies, and I think the explanation I have given of muscular strain is the correct one.

The next case is also one of considerable interest. He was a man aged 28 when he came to me in December, 1882. He had had symptoms of nystagmus for two years, but particularly for the last three months. He was an engineman at the bottom of the pit. My notes made at the time were sufficiently complete, but the characteristics of the case were unusual, and I determined to try to find him again. I did so, and he came to me quite recently. The facts are briefly these. The name given to his employment is misleading, and although the place where the engine was situated is lofty (20 feet), he had a lot of work to do attending to pipes under 5 feet and less—his own height was about 5 feet 10 inches. He had to lie on his side attending to the pipes, and his work necessitated much turning of his head on one side, very similar, as he said, to that assumed by a man "holing." He worked with paraffin lamps, but when it was necessary to go to the donkey engine, which was some distance away, he used a safety lamp. Acting on my advice (given in 1882), he had ceased to do this kind of work, and obtained employment on the pit bank. He still, however, has to go into the pit frequently, and still uses a "safety lamp." He travels with it 1,000 yards down an incline, and 500 more to the workings (donkey engine). He does no work now necessitating such a position as was formerly the case, and, though he still uses a safety lamp a good deal, he is perfectly well, and has been so for several years. There are no oscillations of the eyeballs discoverable by any means, nor has he had any symptoms since shortly after changing his work.

The remaining two cases are of peculiar interest, and I must direct special attention to them because they worked in a good light, and the question of safety lamps or imperfect illumination has therefore no place. They are both occupied at the bottom of the shaft; they have been previously mentioned, but it will be necessary now to go a little more into detail.

The light at the bottom of the pit shaft will be recognised to be good. As before mentioned, in some pits it is lighted by the electric light or gas, and in others by large paraffin or oil lamps.

One of these patients was a man, J. H., who came to me in October, 1890. He had suffered from the lights dancing for about three or four months; nystagmus was present, but not very markedly. He worked at the bottom of the shaft as an "onsetter." There is, he says, "plenty of good light from oil lamps." He has never worked at the coal face or as a practical miner.

I find he is "head hanger on," his work being to ring off, that is, when the tubs are full he signals to the top, and whilst these go up the cage comes down with the empty tubs. He stands at his work, and has to look up to the cage ascending and coming down, his head and eyes being frequently turned in an obliquely upward direction, with his head on one side. Other men shove the tubs on to the cage. The facts here given as to this man's work were supported by three other patients from the same pit, who constantly saw him at his post. Besides this, as the patient came up to one, he did so with his head on one side.

The other, T. M., was a man, aged 28. He has nothing to

¹⁰ Carpenter's *Physiology*, p. 896.

¹¹ The motions cease on looking downwards.

do with coal getting. He says "There is plenty of light from big paraffin lamps." I need not further detail his case.

Now in these two cases the "light" question does not come in. There are many occupations above ground pursued in no better or even in worse light. I think the explanation of the causation of nystagmus given is correct. Viewing the five exceptional cases together, it is clear that there are instances of men working underground who suffer from nystagmus, and though not working at coal getting, are pursuing their avocations in a manner that is not irreconcilable with the views I have set forth as to the prime cause at work in occasioning the disorder.

I must pass by many interesting points connected with treatment, and allude only to some of the results, which lend valuable aid in support of the contention as to the part played by the miner's manner of work in causing his malady.

Formerly it was my practice, after a period of rest in severe cases, or more quickly in slighter ones, to advise the patient to seek some work outside of the pit, on the bank, or to obtain some other employment. Increased experience has taught me that leaving the pit, except temporarily, is unnecessary. I lay particular stress upon this.

Included among the 120 cases with which I have dealt in this article—or really 106, because 14 were not actual patients, but were included in a special inquiry as to naked lights—will be found several instances which will bear out the statement that a change of work has been followed by improvement, and they have been enabled to continue working underground. All that has been necessary is that any occupation causing such a constrained position as holing should be discontinued; safety lamps have been used as before.

The following is a particularly interesting case. W. B., aged 29, came to me at the Infirmary on November 11th, 1890. He has worked in the pit for twenty years, and has used safety lamps for fourteen years. He has been suffering from symptoms for about the last two or three months. Quite recently he became worse, and was compelled to leave his work, and, thereupon came to me. He was similarly afflicted five years ago, and was under my care then, and recovered. On my advice he obtained work outside the pit. He continued at this for twelve months, then he went into the pit, looking after the roads and ponies. Then for six months he did getting coal down after it had been holed by others, and removing the "spraggs" or wood supports. He did all this work with safety lamps, be it remembered, without finding it, as he says, trying to his eyes. He thought he might return to his old occupation of holing. He did so, and at the end of four months he was compelled to leave his work and again seek my aid, and this notwithstanding a respite of getting on for five years since he had done holing before. His was a bad specimen of nystagmus. By treatment, at first at my hands and then at the medical side of the Infirmary under my friend, Dr. Cocking (for he had also cardiac disease) he has again made a most satisfactory recovery. He will soon be fit, if he wishes it, to obtain employment underground again, but he will not do holing. When the man first came to me five years ago he was a "lamp man." Is it to be wondered at that he is now convinced that to the constrained position necessitated in holing is to be attributed his disorder?

It is unnecessary to give details of other cases. One of the most recent is a man I saw at Christmas last, of whom my friend Dr. Scott writes: "S. has changed his work to 'datalogging'; he lays rails down for trams, and although he is working in quite as bad a light—ordinary lamps (safety)—still his eyes are not so bad."

In conclusion, let me say that it has been impossible in the space at my command to have either dealt fully with the points mentioned, or indeed to bring out all the evidence and facts, which in the course of a long investigation have accumulated in my hands. Many important facts have been omitted; so much, indeed, is this the case, that it is my purpose shortly to publish in book form my observations in a complete manner, and to illustrate by engravings and photographs the various kinds of work pursued in the pit. For the present, I think I have brought forward sufficient evidence to show that not only is nystagmus met with in the workers with naked lights, and that by no means infrequently, but, further than this, instances have been given of its occurrence in men, not practical miners, pursuing their

work in a good light; that it is impossible to regard, therefore, the use of safety lamps as a sole, or even essential, element in causation, and that even imperfect illumination may be absent. On the other hand, the evidence given as to the men seen at work in the pit, the analysis and consideration of the cases, supported as it is by the views of Dransart, Neiden, and Zieminski, point to the position assumed at work as the prime element in causation. It has been further shown how such a theory is consistent with the symptoms present, and that the results of treatment so based are eminently satisfactory.

TUBERCULOSIS OF THE CHOROID: A FURTHER CONTRIBUTION.

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SINCE December, 1889, when I published an article on the above subject in the *Illustrated Medical News*, four additional cases have come under my observation, and two of these are of interest in so far as they illustrate the fact that tubercles in the choroid are to be found in cases other than those of general tuberculosis, both these cases occurring in patients who gave evidence of a localised tuberculous complaint. An account of the case suffering from general tuberculosis, of which the drawing of the fundus now appears for the first time, is to be found in the *Illustrated Medical News*. It is the case of E. S., of which a full history will be found there; and I content myself with detailing the fundal appearances, of which the drawing gives a very good idea.

E. S. Right eye. June 17th, 1889.

Right Eye.—No neuritis, but vessels inclined to be "corkscrewed." Between the descending veins is a patch irregularly oval, and a trifle smaller than the optic disc, which is a light fawn colour. It has a reddish-black irregular margin, the redness due to the red reflex showing through the retinal pigment, which is here a shade or two darker. At one spot the retinal pigment is, as it were, shaved off obliquely, and has the appearance of gradually thinning off towards its edge. In the centre is a minute narrow black ring of retinal pigment, and this ring is filled in with the same fawn colour which is seen in the body of the tumour. This body is crossed in the centre by an artery, which runs due south; the