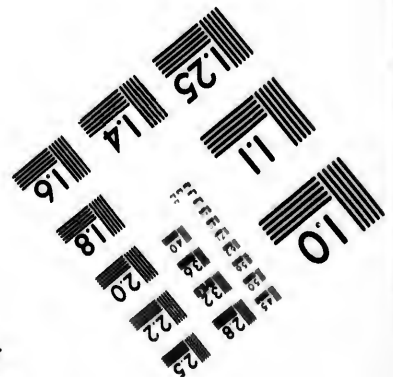
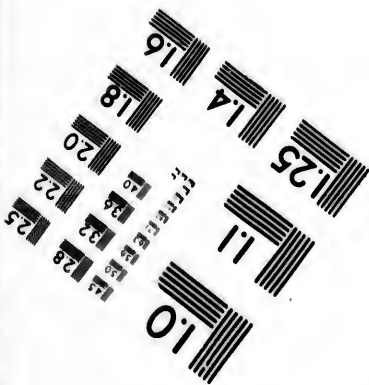
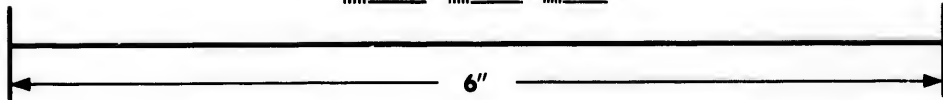
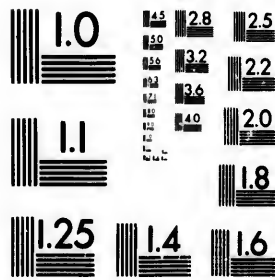


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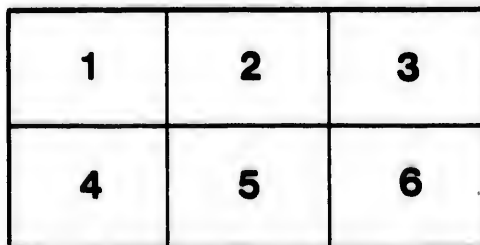
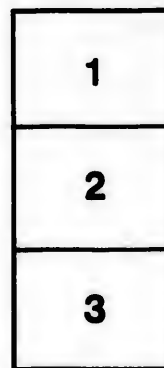
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reprinted from THE MEDICAL NEWS, August 11, 1888.]

DR. CASEY A. WOOD,
204 Dearborn St.
CHICAGO

A CASE OF LIGHTNING SHOCK WITH RECOVERY.¹

REPORTED BY J. B. PAIGE, V.S.

With remarks.

BY FRANK BULLER, M.D., M.R.C.S. ENG.
PROFESSOR OF OPHTHALMOLOGY IN M'GILL UNIVERSITY;

AND

T. WESLEY MILLS, M.A., M.D.,
PROFESSOR OF PHYSIOLOGY IN M'GILL UNIVERSITY, MONTREAL.

REPORT OF THE CASE. (BY J. B. PAIGE.)

The accident about to be described occurred in Prescott, Massachusetts, during a terrific thunder-storm, July 29, 1887, about five o'clock P. M.

Lightning struck the house, to all appearances the chimney of the upright part first. At the roof the current divided into three parts, one following the chimney down to the floor of the second story, then passed along a stove-pipe out of the chimney, and partly to a nail in the floor by the legs of the stove, and thence by the timbers to the earth. A second subdivision of the current followed a rafter on the north side of the roof, after leaving which it could not be traced. This rafter was completely torn from its place. A third current passed down a rafter on the south side of the roof. At the lower end it divided again, one portion following the

¹ Read before the Medico-Chirurgical Society of Montreal, March 16, 1888.

finish of the roof, passed along the other side of the L to the opposite corner, followed the track of a rolling door and reached the earth by the corner post of the house. The other part coursed along the studding of the house, near the window, and passed to the earth. Attached by a screw to the upper casing of the window was a large iron hook on which was suspended, by a brass chain, a bird-cage. One part of the current going by this chain to the bird-cage, left it at one corner, entered the body of the subject of the accident, and left the room by a nail in the floor.

That the electrical influence in this quarter was intense is proved by the fact that the links of the chain, in some places, were nearly melted apart, while the solder at the corner of the cage, where the fluid left, was completely melted. Again, the nail by which it passed through the floor was considerably roughened. It appeared as if it had been partially melted at a high temperature.

The position of the four persons about the place at the time the house was struck is represented by the letters A, B, C, D, the first three being out of doors, seated upon the floor of the piazza. D, through whom the electricity passed, was seated just inside the window.

The distance from A to B was about two feet, from B to C eighteen inches or two feet, and from C to D six or seven feet. As a result of the shock D was rendered completely insensible, C was thrown upon the floor and was unconscious for a second, in fact did not even hear the report, which was like the peal of heavy artillery. Although C and D were so much affected, neither A nor B felt the shock.

This all took place before one could realize what had happened.

A, B and C, who regained consciousness immediately, ran from the house about twenty or twenty-five feet upon the lawn. Thinking of their companion inside, they returned and found that she had been thrown from the chair in which she was sitting directly across another chair, a distance of two or three feet. She was taken out to the piazza immediately, and her condition was found to be as follows: Completely unconscious; motionless; muscles relaxed; left eye closed, right, open; face purple; pulse at wrist imperceptible; neither heart sounds nor respiratory murmur to be heard.

Later, an examination showed the course of the electric current to be as follows: It struck the head above the left eye, midway between the eyebrow and hair, which was apparently the part nearest the corner of the bird-cage; passed along in front of the ear, then to the central line of the thorax, descending by the stocking supporter, which was attached to the corsets; thence to the top of the stockings, leaving marks upon both limbs, but more especially upon the left, on the back of which, just above the knee-joint, was a burn about the size of one's hand. It had the appearance of an ordinary burn, and was only superficial. No trace of the current could be detected again until the foot was reached, from which it passed off by the joint of the great toe, tearing a place about two inches in diameter in the stocking and slipper, but not leaving the slightest mark upon the skin. With the exception of the burned spot on the posterior part of the left leg and one or two small burns on the body and the right leg, hyperæmic lines, alone, marked the course of the electricity in its passage over the body.

After removal of the patient to the piazza, the

clothes about the neck and chest were loosened and artificial respiration commenced. In from three to five minutes the first sign of life appeared in the flexion of the right leg. The dark color disappeared from the face and the pulse could be felt at the wrist. It was then weak, rapid and irregular. The treatment was kept up for ten or fifteen minutes, until the body began to feel cold, when the woman was removed to the house and placed upon a bed. The moving caused a disturbance of the circulation, as was shown by the pulse, which became very faint and fluttering. In order to encourage the circulation, hot fomentations were applied to the chest, and as soon as they became cold were replaced by fresh ones.

Soon a new train of symptoms set in. There was difficult respiration. The mucus and saliva, which were very abundant, had gravitated back, and could not be swallowed because of complete paralysis of the pharynx, etc. There was, in fact, paralysis of almost all the muscles of the uppermost parts of the body, including the arms. The symptoms were those exhibited by an animal when being asphyxiated: violent muscular contraction, difficult and forced respiration, etc. To remove the saliva and mucus, which caused the obstruction, the head and trunk were lowered. Handkerchiefs were also used. These were placed over the finger and passed back as far as possible into the throat, and in this way large quantities of the saliva and mucus were gotten away.

From one-half to three-quarters of an hour after the accident, consciousness began to return and the muscles of the arm to regain strength. Sight was restored to the right eye, although it could not be moved. Though the subject could hear she could

not speak. This was shown by the fact that when asked to press the hand if she felt better she responded. About this time paralysis began to disappear gradually from the tongue. Improvement continued; brief intervals of sleep were enjoyed through the night, and there was absence of any considerable pain.

The next morning, about twelve hours after the accident, there was sufficient oedema of the upper and lower lids of the left eye to close them completely; this lasted for several days, and when it disappeared there was noticed a slight effusion in the anterior chamber (?) which interfered considerably with vision. There were no signs of inflammation of any of the parts of the eye. There was a complete return of the cerebral functions, the mind being as clear and as active as usual.

The patient could, as yet, swallow only a few drops of ice water at a time, and then with great difficulty. The trouble seemed to be in the pharynx, as it was easy enough to carry the water backward.

The paralysis passed away slowly, so that in about two weeks solid food could be swallowed. The strength of the patient was maintained during this period by thin gruels, brandy and a fluid preparation of beef (*Bovinine*).

To allay the great thirst of the first twelve hours, small pieces of ice were kept in the mouth.

Twelve or fourteen hours after the accident, intense pain set in about the head, neck, arms and chest. That about the chest continued during the day, but was somewhat relieved by mustard poultices. The pain in the head was constant and very severe, and lasted seven days. During the first five it was relieved somewhat by cold applications, which were replaced by hot ones on the sixth, and continued

for two days. After this, the pain occurred only occasionally. The pain in the neck and arms was not so constant, but when present was severe. Shampooing relieved it more than anything.

The severe pain prevented sleep at night. This was combated by morphia and atropia, $\frac{1}{8}$ grain of the former and $\frac{1}{200}$ of the latter to the dose.

For five or six weeks the left eye was drawn inward and upward, double vision resulting.

At no time during the illness did the temperature rise higher than 101° F.

The functions of the urinary organs were not interfered with at all. Menstruation was in progress at the time of the accident, but continued as though nothing unusual had happened.

Constipation was marked for a time, there being no movement of the bowels for five days after the accident. This was brought about by the use of enemas and small doses of gray powder. After this, the bowels acted regularly.

The treatment of the case consisted in combating the symptoms as they appeared ; but it is very doubtful if any good was accomplished by the use of drugs, with the exception of the morphia, atropine and gray powder, although bromide of potassium, quinine and several other remedies were used.

The patient remained in bed two weeks, then sat up for a short time daily, until at the end of four weeks she was able to take a ride of thirteen miles in the cars to her home.

Complete recovery has taken place with the exception of the left eye ; the vision of which is somewhat impaired.

The management of the case immediately after the accident was conducted by Mr. Paige, then an undergraduate, who was on the spot at the time.

REMARKS ON THE OPHTHALMOLOGICAL ASPECTS OF THE
CASE. (BY DR. FRANK BULLER.)

There was a steady improvement in the visual acuteness for some two months after the accident, but no perceptible improvement has taken place since then. The patient suffered severe pain about the eye and left side of the head for about a week after the injury. There is nothing abnormal in the external appearance of the eyes nor any evidence of injury to the adjacent parts.

The conjunctiva, cornea, anterior chamber and iris appear just as in the other sound eye. The pupil is of medium size, but does not respond to light quite so promptly as that of the other eye. The existing visual defect prevents an accurate estimate of accommodation, but the ciliary muscle is certainly not inactive. Vision of right eye = $\frac{6}{VI}$, slightly better

with + 0.5 c. ax. 90°. Left eye, vision = $\frac{20}{L}$, not improved by any glass. All the extrinsic muscles appear to do their work efficiently.

Two hours after free instillation of solution of homatropine, gr. viij ad ℥j, there is R. H. = 1 D., vision = $\frac{6}{VI}$ L. H. = 1.5 D.; vision = $\frac{6}{XV}$. Under ordinary circumstances there is binocular vision, but a vertical prism gives a lateral convergence = 18°, abduction = 3°, adduction = 42°, and ? right hyperphoria = 2°.

It will thus be seen that there is an insufficiency of the external recti which may be her normal condition, or, in view of the fact that there was no visual disability of either eye prior to the accident, it is

more probable that the left external rectus had not fully recovered from the effects of the injury.

By facial illumination there is seen to be a considerable opacity at the posterior surface of the lens very like that of an ordinary posterior polar cataract, with this difference: the opacity is obviously, for the most part, situated in the lens substance, and does not, like the so-called posterior cataract, present a concave anterior surface.

The opacity has a circular outline, but is not sharply defined, and beyond the principal opacity there are some nebulous cortical opacities extending further toward the posterior periphery. The vitreous humor contains a few floating particles so fine that they are seen with difficulty even with the aid of a + 6 D., ocular behind o. mirror. The optic nerve is very pale and its margins slightly blurred, but this may be partly due to the defective transparency of the lens. There is nothing else indicative of an optic neuritis, past or present.

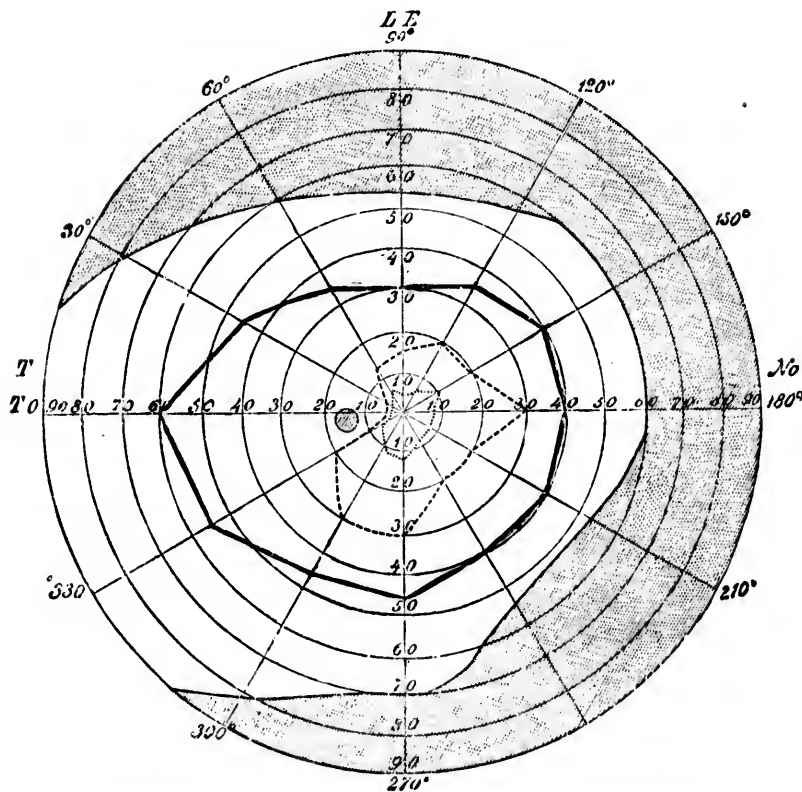
In addition to the pallor of the nerve, there is a considerable diminution in the calibre of the retinal bloodvessels, with loss of the fine vessels on the papilla to about the same extent as may be observed in an ordinary case of moderately advanced simple atrophy. Several of the larger vessels, both veins and arteries, have whitish borders for some distance in the retina. Other than these there are no visible changes in the fundus oculi until we come to the extreme periphery, at and somewhat below the horizontal meridian. Here there is a broad patch of irregular choroidal pigmentation composed of ill-defined masses of dark pigment, but not so black as the pigmented deposits commonly seen in choroiditis. The anterior boundaries of the pigmented area extend beyond the ophthalmoscopic area, but about

the centre of the patch there is an irregular break about the size and shape of two of the papilla partly overlapping each other. This patch is itself partly covered with pigment, but is of a dull orange color. If due to atrophy of the choroid at this part, the atrophy is not sufficiently advanced to show the tendinous whiteness of the sclerotic. It would seem to be either a rupture of the choroid at this part or an imperfectly absorbed effusion of blood, or, what is more probable, both these conditions are present.

It will be seen from this description that the injury has resulted in damage to the external muscular apparatus, the crystalline lens, the choroid and, lastly, the optic nerve. No doubt the visual defect is chiefly due to the latter, for there is a very pronounced concentric limitation of the visual field, such as we might expect to find in partial atrophy of the optic nerve, but which could not have resulted from any of the other lesions mentioned.

The color sense, though impaired, is pretty uniformly restricted for all colors (see chart of field). It is not easy to explain how this has happened, since we have no knowledge of the ophthalmoscopic changes shortly after the injury.

There might have been an effusion into the tissues of the orbit causing pressure on the optic nerve behind the eye; or an effusion of some kind into the sheath of the optic nerve, or an interstitial neuritis as a result of concussion of the nerve, and any one of these conditions might have resulted in the existing partial atrophy.



The white area in the chart of the visual field represents the normal limits of the field of vision for white of one eye whilst the individual is steadily gazing at the central point.

The heavy black line in the chart represents the actual (much diminished) area of the patient's visual field for white. The interupted and dotted lines are the areas for the colors red and green respectively. These are also much contracted—about in the same proportion as the field of vision for white, but less regularly so.

I have not been able to find in ophthalmic literature any case of injury to the eye from lightning, in which an ophthalmoscopic examination was made shortly after the injury, with the exception of Brude-

LIGHTNING SHOCK WITH RECOVERY. II

nell Carter's case (*St. George's Hospital Reports*, vol. v. p. 322), incorrectly credited to H. Power by T. Leber, as well as by de Wecker and Landolt. In this case such an examination was probably made, but there is no mention of ophthalmoscopic changes; moreover, the injury was not caused by direct contact of the electric discharge with the patient's body, and as the man recovered perfect vision a few days after the injury it is not at all likely that any visible intraocular lesions were present. Of the few cases that have been reported since the ophthalmoscope came into use, those presenting intraocular lesions were all actually struck by the lightning. In one (reported by T. Leber in *Gräfe's Arch. für Opth.*, Band xxviii.) the general disturbance, burning of the surface, shock and paralysis, were greater than in our case. In this instance, too, both eyes were seriously damaged. Nevertheless the ocular lesions in our case are remarkable both in their number and severity.

The injuries known to have been inflicted on the eyes of the few cases hitherto reported, may be summed up as follows: Paralysis of the muscular apparatus, including the muscles of accommodation, cataract, deep-seated changes in the ocular tunics, such as ruptures of the choroid, choroidal and retinal hemorrhages, detachment of the retina, paralysis of the optic nerve in the form of atrophy of the nerve. Four of these conditions were present or had existed in our case, and may fairly be attributed to the injury, since, as already stated, there was no known visual abnormality prior to the accident.

REMARKS ON THE GENERAL PHYSIOLOGICAL ASPECTS
OF THE CASE. (BY DR. WESLEY MILLS.)

The history of the above case may be summarized as follows: The subject of the accident is a young woman, healthy, about twenty years of age, married, who was struck by lightning some six months since. The immediate effect was instant and prolonged loss of consciousness, complete cessation of respiration, and partial arrest of the circulation. The first sign of life appeared in from three to five minutes. The circulation remained in a very feeble condition for some time. When the respiratory system resumed its functions, breathing was greatly impeded by accumulations of saliva in the pharynx. Consciousness was restored in from one-half to three-quarters of an hour. There was paralysis of the muscles concerned in voice production and deglutition, and of the arms and probably other parts. After twelve hours, recovery of the higher cerebral functions was complete, with partial restoration of the ability to swallow. Dysphagia persisted in some degree for more than two weeks.

There was severe pain in the head, chest and arms, most marked in the head, and lasting for several days.

An internal strabismus of the left eye lasted for five or six weeks, causing diplopia, then gradually passed away.

The catamenial flow, in progress at the date of the accident, continued as usual. The urinary functions were normal throughout, but constipation was pronounced for some days. The patient has completely

recovered, with the exception of the vision of the left eye.

The treatment was, first, artificial respiration, with, later, the addition of warm fomentations to the chest; the subsequent symptoms were combated by morphia, atropia, gray powder and massage. The young woman's general health continues to be excellent.

It is not my intention, in these remarks, to enter into the subject of lightning shock in general, but to confine myself to a brief explanation of this particular case. Its scientific interest lies in the fact that it is an example of one of Nature's physiological experiments—or, shall we say, in consequence of its violent character and the nature of the results, pathological. At all events, it is a lesson in human physiology, as I conceive it; and human physiology proper is so meagre that every scrap should be gathered together and carefully preserved. In order to keep these remarks and the paper as a whole as brief as possible, I shall indicate my own views of the case without entering as fully as might be into the evidence on which they are based.

The unconsciousness was owing to the shock (abolition of function) of the cortical cells (and others) of the cerebrum, arising from the violent impulses reaching them chiefly along the nerves, and not by the direct entrance of the electric current into the brain—*i. e.*, the effect was physiological, not physical, chiefly. The cessation of respiration and (partially) of circulation is to be traced to a similar action on the nervous centres presiding over these

functions. The heart was slowed, and its ventricular action rendered highly intermittent, owing to impulses through the vagi nerves. The condition of the circulation may be considered a reversion for the time to the reptilian type (see a paper on "Reversion," by the present writer, in the *Canada Medical and Surgical Journal* for April, 1888); but the vagus is a trophic nerve, and the heart, though being injured by the venous blood, is also being benefited by the impulses descending the vagi—hence, a preparation for recovery.

The artificial respiration and heat furnish oxygen and—what is essential to mammalian functional action of all kinds—a certain temperature. The mammal, in this case, is presently restored to its normal grade, and leaves the reptilian (cold-blooded) condition, in which it could exist for a brief period.

There are many indications to show that the cord did not suffer as much as the brain, which is explicable by the site of the original impact of the current (head). Hence the leg can shortly be drawn up—a revived reflex, probably. The menses are not interrupted. On the other hand, there is constipation not to be accounted for wholly by the inactivity in bed, but by the inhibitory influence of the brain over the cord, which latter Goltz has clearly proved to be alone essential for defecation. At first it is a shade surprising that the menses were not interrupted as the action of the alimentary tract evidently was (constipation); but when the length of the latter is remembered and its abundant nerve-supply—the

extent of cord thus nervously connected, etc.—the apparent mystery clears up in part, at least.

The paralysis of the muscles of the larynx, pharynx, etc., is to be traced to the effect of the current on the nerves themselves or their centres in great part, rather than to its direct action on the muscular tissue, though the latter need not be wholly excluded. This view is borne out by the pain which followed the paralysis, and which is best referred to the molecular changes in the nerve-tissue causing increased resistance to the passage of impulses which emerge in consciousness as pain. Since there was complete and rapid recovery of all the mental powers, the injury was probably chiefly to the nerves or the nerve-endings. Was the difficulty in respiration in this case owing to the secretion of an excess of saliva, or to the normal quantity not being swallowed at all, or to both? Experiment has shown that in the lower mammals an increase of secretion may be induced in two ways: either by stimulation of the nerves of the salivary glands, or by section of the nerves, which is, of course, equivalent to paralysis. Usually, however, in the cat, etc., the secretion following section of the nerves ("paralytic secretion") does not set in for some hours. One powerful electrical stimulation of the chorda tympani nerve will cause, in the lower animals, a considerable flow of saliva, which lasts for some time after the current is withdrawn. It may be that there was an excessive secretion in our case, due to paralysis of the nerves presiding over the secretions of the glands; but, upon the whole, it seems safest to

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regard the effects as due to failure in deglutition, with a possible excess of secretion, the result of the stimulus of the nerves by the electric current.

The good results following the use of morphia and massage seem to be in harmony with the explanations advanced as to the cause of the symptoms.

Why were the injuries to the eye most lasting? The œdema may be explained, either by a local or central effect through the nerves. Taking into account the fact that the current impinged so near the eye, it is likely that both factors enter into the result. As none of the nerve-endings, we have reason to believe, are so delicate, so readily injured as the retina, it is not difficult to understand why the intraocular effects should be so permanent or, in fact, should be progressive, or even multiplied in kind.

Would this patient have recovered without the assistance rendered just after the accident? Considering that respiration was suspended, that the circulation, even with artificial respiration, was so feeble that the temperature fell, that consciousness did not return for so long, it does not seem reasonable to believe in the possibility of spontaneous recovery. But the case does seem to teach, in the clearest way, the importance of using such means as those employed in this instance promptly and perseveringly.

