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IS THE ELECTRIC LIGHT INJURIOUS  
TO THE EYES.

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BEFORE proceeding to the direct answer of the question, it may be well to glance at the larger one that refers to the relation of the electric light to general hygiene.<sup>1</sup> Most every one has a general impression that the electric light is much superior to other methods of artificial illumination, so far as concerns our general health and comfort, but few could give a reason for the faith that is in them. They will come out of a theatre, music hall, church, etc., with headaches, lassitude, exhaustion, their bodies bathed in sweat, all resulting in colds, and a

<sup>1</sup> For those especially interested in the subject, besides the references given, relating to the relative production of heat, carbon dioxide, and other combustion-products, and their influence upon health, the following may be of service: Cohn, Untersuchungen ueber Tages und Gas-Beleuchtung, Berl. klin. Woch., 1885. Cohn, Ueber den Beleuchtungswerth der Lampenglocken, Wiesbaden, 1885. Cohn, Studien, etc., Vierteljahresschrift f. öff. Gesund., Bd. xv. Heft 4. Pettenkofer, Archiv f. Hygiene, Band 1, p. 210. Reuk, Centralblatt f. Electrotechnik, 1885, p. 210.



multitude of major and minor affections, and never utter a word of protest or complaint against the culpable and parsimonious management that permits the vitiation, poisoning, and superheating of the atmosphere by a thousand gas-jets. It is certainly not too much to urge, as has been done (14), that the matter should be under the control of the law, and that electric lighting is of political importance on a par with the supply of pure water and drainage. The following figures, from a trustworthy source (14), are so eloquent that they need no comment or explanation :

TABLE.

Burnt to give light of 12 candles equal to 120 grains per hour.	Cubic feet of oxygen con- sumed.	Cubic feet of air consumed.	Cubic feet of CO <sub>2</sub> produced.	Cubic feet of air vitiating.	Heat produced in 100 lbs. water raised 10° F.
Cannel gas,	3.30	16.50	2.01	217.50	195.0
Common gas.	5.45	17.25	3.21	348.25	278.6
Sperm oil,	4.75	23.75	3.33	356.75	233.5
Benzole,	4.46	22.30	3.54	376.30	232.6
Paraffin,	6.81	34.05	4.50	484.05	361.9
Camphine,	6.65	33.25	4.77	510.25	325.1
Sperm candles,	7.57	37.85	5.77	614.85	351.7
Wax candles,	8.41	42.05	5.90	632.25	383.1
Stearic candles,	8.82	44.10	6.25	669.10	374.7
Tallow candles,	12.00	60.00	8.73	933.00	505.4
Electric light,	None	None	None	None	13.8

It is thus seen that, as compared with the electric light, gas consumes over seventeen times as much air, vitiates three hundred and fifty times as much, and then, adding insult to injury, gas heats the

foul residue twenty times as much as the electric light would do.<sup>1</sup>

In a recent address before the British Association,<sup>2</sup> Mr. Preece shows that gas absorbs 68 watts, whilst electricity (arc) absorbs only 5, and the glow light but 3 watts, as the energy required to produce a light of one candle-power. He also shows that in London the cost of producing one candle-light for one thousand hours is, for gas, 30 cents; oil, 16 cents; electricity (glow), 18 cents; and arc, 3 cents.

There is, therefore, no excuse for longer delay in introducing this superior form of illumination into public meeting places. The long-suffering public should arouse their masters to a knowledge of their duty in this respect. The latter have no longer even the excuse of financial expense.<sup>3</sup>

But there has grown up a somewhat popular notion that the electric light is hurtful to the eyes, and one finds, even in the literature of the subject, some very absurd prejudices and nonsensically windy disquisitions concerning the noxious action of the

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<sup>1</sup> From experiments made in the hall of the Birmingham Festival (14) it was shown that when gas was used the temperature near the ceiling rose from 60 to 100 degrees after three hours' lighting. This was equal to adding 4230 persons to the full audience of 3100. The vitiation of the air was equal to that produced by 3600 additional persons. When electricity was used the temperature rose only 1½ degrees in seven hours, and the air was, of course, not vitiated at all.

<sup>2</sup> See Science, Sept. 28, 1888.

<sup>3</sup> As to this aspect of the question see some most interesting and suggestive extracts from Lodge's *Modern Views of Electricity*, in Science, Sept. 28, 1888, p. 153.

mysterious "chemical rays" said to predominate in the electric light spectrum.

Having had a number of patients who persisted in ascribing certain ill-defined ocular affections to the action of the electric light, I determined to see what evidence existed of the supposed noxious influence. The following is the report of the cases published of ocular troubles resulting from an exposure of the eyes to the electric light, and of the conclusions deducible from their consideration. I may say that, so far as my own experience is concerned, I found in my patients who complained of the electric light, that their ocular troubles could usually and easily be accounted for by some error of refraction, overwork, etc.

The question of nomenclature may be noticed in passing. The term *electric ophthalmia* has been proposed and used of the ocular affections to be described. But the popular use of the word ophthalmia confines it almost exclusively to conjunctival troubles, whilst if not others, there are evidently retinal lesions in these cases. Moreover, there is no sense in the term electric ophthalmia. Electric light ophthalmia would be less criticisable, though still very objectionable. Electric sunstroke, electric light sunstroke, etc., are highly ridiculous in themselves, besides importing into the agency the element of heat, as certainly present in sunstroke, as it is certainly absent in the ocular injuries of the electric light. We, therefore, must use some circumlocution to describe these cases.

I proceed at once to give a condensed *résumé* of

the cases so far reported in which the electric light was the cause of ocular troubles. They number twenty-three, though several cases are evidently included in Defontaine's account.

1. Terrier (26)<sup>1</sup> cites a letter of Professor Gariel stating that Foucault, in 1843, was attacked with a severe ophthalmia, due, according to his own belief, to the electric light. No particulars are given.

2 and 3. Two chemists, according to Professor Charcot (2), following some experiments in fusing certain substances with a 120 cell Bunsen battery, were seized during the night with pains in the eyes, luminous sensations, and erythema or "electric sunstroke of the face." The ocular troubles were less severe than the cutaneous erythema. There was desquamation of the affected skin in four days. Charcot attributed the injury to the chemical rays, and recommended spectacles of uranium, which substance retains a large proportion of these rays.

4. Little (12) reports the case of a gentleman, who in experimenting in a laboratory, with the electric light, neglected upon one occasion to protect his eyes with his dark glasses. His right eye was exposed to the light. He was blind for a few minutes, and for several days thereafter he had great photophobia and headache. Two months after this accident the physician was consulted on account of dimness of vision and dark spots before the right eye, whose acuteness was  $\frac{20}{L}$ . Ophthalmoscopic examination showed the optic nerve and adjacent retina affected. Tinted glasses and rest were ordered. No subsequent history.

5 and 6. A case is reported by Rockliff (9) of a work-

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<sup>1</sup> The reference numbers throughout the article refer to those of the bibliography appended.



or two minutes, a certain degree of inflammation resulted. A too strong current, producing a violet light, or an insufficient one, producing an orange light, results in less trouble to the eyes than the normal current strength—white, tinted with a sky blue. Irregularity of the light is more dangerous than when it is steady. The patient reported that his first symptom was a sensation as of a multitude of duplicates of the arc; or, with movements of the eyes, a blinding glare, very confusing for a time, and forming a sort of screen before objects. At first the image was the same color of the arc, but soon this gave place to the complementary color which persisted longer, and which disappeared very slowly. When this had entirely passed away it could be recalled by rapidly opening and closing the eyelids. The severity of the lesion was proportionate to the length of time afterward that the patient could thus reproduce these images. If this were during one hour, the patient knew that the inflammatory symptoms would finally ensue, and so he proceeded at once with the remedies that would serve to cut short the attack. The patient had had three separate attacks, accompanied by the usual symptoms of a feeling as of dust in the eyes, lachrymation, intolerable pain, etc. Lotions of sulphate of zinc and opium were used. Patient had not noticed any swelling of the lids.

9. Nodier's case (7) was that of a naval officer whose duty it was to experiment with the electric light. The light was equal to 1600 Carcel jets, surrounded by a glass 40 cm. from the focus, and the officer's eyes were subjected to this light for two hours without protecting spectacles. This was followed soon by headaches and pains in the eyes. The next day the conjunctivæ were red; there were lachrymation, sclerotic hyperæmia, pericorneal circles, myosis, photophobia, *muscæ volitantes*. These symptoms disappeared slowly in three days. Both eyes were affected alike, and there was no erythema of the skin. The

diagnosis was hyperæmia of the retina and conjunctiva. The treatment consisted in zinc collyria, tepid compresses, and rest.

10. In a similar case reported by Nodier (7) the light was only equal to 300 Carcel jets, and the symptoms were light. There were slight cephalalgia, pricking sensations of the eyes, profuse lachrymation. The hyperæmia, pericorneal circle, sclerotic congestion, myosis, and photophobia were only of one eye. The attack passed off in twenty-four hours. The treatment consisted in atropine instillations, belladonna ointment above the orbit, compresses, etc.

11. Dr. Dujardin (26) describes the case of an electrician whose occupation was to charge the accumulators, and who subjected his eyes to the influence of a strong spark. There was photophobia and redness of the bulbar conjunctiva for twenty-four hours.

12. In a communication of Dr. Martin to Dr. Terrier (26) the case of M. L. is described. He had been present at the electric welding. He had worn protecting colored glasses, but in order to see more exactly he had taken them off for a moment. No evil results were felt until night, when he was seized with intense heat of the face and eyes, lachrymation, and such great pain in the eyes that he was unable to open them, and believed himself blind. The pain increased to real torture, the face was injected, the skin thick and rough, and hot. Tears flowed down the cheeks, the lids were swollen so that they could not be opened, the spasmodic closure of the same, and contractures of the facial muscles being increased by the attempts of the physician to examine the eye. By the aid of cocaine, it was found that the white of the eye was but little injected, the cornea intact, the pupil contracted. The palpebral conjunctiva was carlet, but not swollen, the vision normal. Soothing collyria and cocaine were administered, and the ocular

symptoms gradually disappeared in a day or two. The skin of the face was affected more than a week.

13. Sous (23) records the case of M. D., who, though protecting his eyes with dark blue glasses, often looked closely at an incandescent light used to illuminate the work. During the night he was seized with violent pains in the eyes. His eyes and orbits seemed filled with coals of fire. There was intense photophobia, not a ray of light being permitted by the patient. A cherry-laurel water lotion was prescribed, and recovery followed in two days.

14 to 20. Terrier (26), quoting a letter of Dr. Faucher, cites the cases of Messieurs Faucher, Morin, and four assistants, who, from the effects of the intense light in some experiments, had an intense congestion of the conjunctivæ for three days, together with very painful sensations of heat, dryness, and as if foreign bodies were in the eyes. One of the workmen had also an intense "electric sunstroke" of the hands and face.

21. According to Terrier (26), a Mr. N., of Lille, after being present for one and one-half hours during the welding of some metals by electricity, remarked immediately that his eyes were very red. The injection of the eyes and erythema of the face continued that day, and during the evening he noticed malaise, heaviness of the head, and feverishness, with painfulness of the eyes. During the night, there were intolerable pain and intense photophobia, with lachrymation, which continued for a day or two; he was able to return to his work in four days. The treatment consisted in applications of ice and cocaine instillations.

22. Defontaine (22) describes the "electric sunstroke" of the workmen employed in the electric steel-welding works at Creusot. The intensity of the light is equal to about 10,000 Carcel lamps. The men do not approach nearer than fifteen to thirty feet, and though there is at this distance no heat, they begin to feel, within two

hours, a burning sensation in the exposed skin of the face and neck, described by one of the men as exactly like that previously experienced by him in a veritable case of sunstroke. The skin is sensitive to the touch, and of a reddish bronze hue. Though the eyes were protected with glasses so dark, that seen through them the disk of the sun was hardly distinguishable, there soon followed a temporary blindness of a few minutes, and for an hour or more thereafter objects seem to be suffused in a decided yellowish saffron hue. The conjunctiva was very hyperæmic, and this lasted for forty-eight hours. There was the extremely painful sensation, as of a foreign body under the lids, and lachrymation was excessive. Cephalalgia and insomnia with slight feverishness were noted. Within the next five days there was desquamation of the entire face in large sheets.

23. Terrier (26), in describing a similar case to the last, notes especially that vascularization of the conjunctiva was particularly noticeable in the part exposed by the opened lids, and when the conjunctiva was covered by the lids there was hardly any injection. It may also be remarked that, unlike all others, he found the pupils dilated. They were little sensitive to light.

If from a review of these cases we try to make up a clinical picture of the disease, we at once strike upon the etiology, and therein lies the greater part of the differences that have arisen in the discussion of the subject. To this *vexata questio* we must direct our attention.

The first fact that strikes our attention is that the subjects were nearly all scientific experimenters, or workmen about the light who were compelled to approach either very near the same or to leave their eyes a long time subject to the influence of the rays.

So far as I have found, there is not a single well-authenticated instance of ocular trouble from the use of the electric light as a simple illuminant. It is a fact well known that we may blind ourselves permanently by staring into the sun, and yet diffused sunlight is, of course, the natural stimulus of the eye. Whatever prejudice may linger in some minds against the electric light properly used as an illuminant may therefore be dismissed as absolutely without clinical proof.

We next notice that the cases cited occurred in those not protecting their eyes in any way, or insufficiently. With this fact we come to the consideration of the real cause of the lesion. It has been ascribed to the supposed excess of chemical (blue, violet, and ultra-violet) rays in the electric light spectrum. Let us see how far this is true.

Rendering the yellow rays equal in the spectra, Meyer (*Centralblatt für Electro-technik*) has analyzed the spectra of the two forms of electric light, with solar light as a term of comparison, with the following results :

	Gas.	Incandescent lamp.	Arc lamp.
Red . . . .	4.70	1.48	2.09
Yellow . . . .	1.00	1.00	1.00
Green . . . .	0.43	0.62	0.99
Blue . . . .	0.23	0.21	0.87
Violet . . . .	0.15	0.17	1.07

It is thus seen that all three lights are reddish-yellow as compared with the sun, and that even the arc light is poorer in blue rays than sunlight. This, of course, relates to the visible portion of the spectrum.

As to the ultra-violet portion, Menger (13) says that M. de Chardonnet photographed the spectrum of an incandescent lamp (like Edison's) and found that it did not exceed that of the visible spectrum. This may have been either because of the absorption of the ultra-violet rays by the crystal globe surrounding the lamp, or because the short rays are not produced. If, therefore, these investigators are to be relied upon, and there seems to be no reason for doubting them, there is absolutely no ground for the great burden of complaint that has been brought against the violet and ultra-violet rays of the electric light. They either do not exist or, if so, they are in less quantity than in sunlight. The recommendations of Javal (6) and Fieuzel (6) to use yellow spectacles to shield the eyes from the baneful effects of the short waves, thus fall flat.<sup>1</sup> Cohn calls attention to the fact that the blue rays are not harmful to the eyes, Graefe and oculists of all times having habitually recommended bluish-tinted glasses.

The theory of M. de Chardonnet (17) holds that all the ocular media absorb more or less the ultra-violet radiation, and that to this absorptive power is

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<sup>1</sup> Another reason urged for the adoption of such lenses is that they obviate the chromatic aberration of the eye, by which, theoretically, the focus of the red rays is behind that of the violet. But Helmholtz could not find that visual acuteness was at all lessened by this chromatism. Javal says it is, and that artificial light is insufficient, widens the pupil, and makes the chromatism of the eye perceptible. He would therefore shorten the spectrum, but not by blue glasses which cut off the red end and thus lessen the amount of light-stimulus; but by yellow glasses, that cut off the blue end. It is a case of hypercriticism and supersubtlety.

due the fatigue of the eye. He found (18) that the crystalline has especially the function of intercepting the ultra-violet radiation, but this brings doubly into view the absurdity of the theory; there is no question in the reported cases of lenticular trouble; it is chiefly retinal or conjunctival, if not entirely so. Not only are there no ultra-violet rays to absorb, but the body that absorbs them is an insensitive, unaffected organ.

Over-refinement is carried a step further in the theory of Regnault (1), who ascribes the ocular troubles caused by the electric light to the fluorescence developed in the media of the eye by the action of the violet and ultra-violet rays. He showed that the mammalian cornea is manifestly fluorescent, and the crystalline also, and to a high degree; that the phacocine or central portion of the crystalline is not so; that the hyaloid membrane is the only tissue of the vitreous having a weak fluorescence; and that the retinal fluorescence is weaker than that of the crystalline.

I think we may throw out all theories that explain the lesions as due to a greater or less proportion of the waves of the different parts of the spectrum. Since time began our eyes have been accustomed to all colors, and, besides, the waves deemed especially harmful are innocent by comparative non-existence. To what then shall we credit the trouble? I believe it is due simply to the intensity or amount of the stimulus which, from the natural and physiological stimulus of diffused sun or electric-light illumination passes, by closeness or by duration of observation,

into pathological irritation and even a quasi-mechanical injury. It is simply a question of degree. From the delicate tint of a cold blue through to the more powerful waves of the red end of the spectrum, up to direct gazing at the electric light or the sun, and to the effect of a sheet of lightning (that has produced blindness) it is only a question of intensity or quantity of the self-same stimulus. A temperature of 98° F. is pleasant to the body, but one of twice that amount coagulates its albumins. There is in Italian a gruesome word, the sad record of a savage age: *abacinare*—to hold a heated glowing vessel close before the eyes until vision is destroyed, or but a shimmer of light is left. The idea was not to burn the eyeballs, but to destroy the retina by the intense stimulus. Czerny<sup>1</sup> focussed direct sunlight upon the retinae of animals. There followed coagulation of the retinal albumin, destruction of the rods and cones, and severe inflammation of the retina and choroid, ending in atrophy of the retina. When gaslight was used these results did not take place, but, though tinted glass was interposed, the effects always ensued with sunlight. Deutschmann<sup>2</sup> showed essentially the same fact by inserting in the path of the sun's rays a glass tube filled with cold water, some 20 cm. long. The destruction of the retina was the same as if the warm rays had not been intercepted. The descriptions of cases of snow-

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<sup>1</sup> Sitzungsberichte der Wiener Akademie der Wissenschaften, Bd. 56, Abth. 2, S. 409.

<sup>2</sup> V. Graefe's Archiv, Bd. 28, Abth. 3, S. 241.

blindness—*e. g.*, those of Graddy<sup>1</sup>—read almost exactly like those I have summarized. The same may be said of those cases of injury from exposure to sunlight such as described by Drs. W. Norton Whitney,<sup>2</sup> Sulzer,<sup>3</sup> Haab,<sup>4</sup> Deutschmann,<sup>5</sup> and others who describe retinal injuries from the observations of eclipses, etc., despite the use of protective blue glasses. There is central scotoma, reduced vision, loss of color sensation, photophobia, etc. In Whitney's cases there was a pearl-white spot at the macula, as if its albumin had been coagulated. Briere<sup>6</sup> had a case of complete blindness from the reflex of a lightning-flash from the white street, and Little (12) had a case of blepharospasm lasting thirteen days, from a lightning-stroke.

It is to be noted that the effects of the electric light are not because it is more intense than sunlight. It is, in fact, far less intense than sunlight. Multitudes of people impelled by curiosity have gazed at the ordinary arc or glow lights without a single case of ocular injury. Hardly one would be able to look into the sun in the same way. All the cases of ocular injury from the electric light are due to gazing at it at very short range and for a long time. Compared to daylight, the electric light lessens colors, for red, blue and yellow, one to two,

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<sup>1</sup> Amer. Journ. Med. Sci., Rep. on Oph., 1887.

<sup>2</sup> Annual of Un. Med. Sci., 1887, vol. iii. p. 91.

<sup>3</sup> Klin. Monatsbl. f. Aug., April, 1883.

<sup>4</sup> Correspondenzbl. f. Schweiz. Aerzte, 1882, p. 383.

<sup>5</sup> Graefe's Archiv, Bd. 28, Abth. 3, S. 241.

<sup>6</sup> Gaz. des Hôp., 1876, 333.

three, and, for red, even four. In the establishments for electric welding the great intensity or number of the light waves is so high that not only are the delicate retina and conjunctiva injured, but the skin wherever exposed is inflamed and desquamates from a short exposure to the near and powerful stimulus exactly as it would if exposed to the sun's rays upon a hot summer day.

Another proof that the injury is due, not to a different proportion of the long or short waves, but simply to their great quantity, lies in the fact that the ocular trouble is exactly proportional to the intensity of the light, or, what amounts to the same thing, the nearness of one's approach or duration of exposure. This is particularly clear in case No. 8. I have elsewhere<sup>1</sup> endeavored to show that the retinal intermediate of light and color sensation is a molecular vibration responding, and proportional to the wave-length and number of the received ether-waves—or, in other words, that the retinal function is a delicate and high differentiation of the temperature-sense. Now, just as a certain degree of heat or molecular vibration is grateful and necessary to the general nerve end-organs, but a much higher degree is destructive of them, so it is the same with the retina. Every fact adduced above, together with the symptomatology and pathology of sun-blindness, snow-blindness, etc., goes to show the truth of this conception. Excess of physiological activity everywhere runs into pathological activity. The light of

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<sup>1</sup> Amer. Journ. Oph., July, 1886.

the ordinary glow or arc lamps when diffused, or not looked at directly, is not injurious to the eyes. Neither is it injurious if looked at from a distance (several feet, or thirty, according to its intensity), unless the gaze be fixed upon it for a length of time that more than compensates for the distance. The injury is proportional to the intensity of the light, to its distance, and the duration of the exposure. It may be said that there is absolutely no danger from the use of the diffused light as an illuminant. They who have the care of these lights—scientific experimenters and workmen in the welding-works—such must protect their eyes with colored glasses, whose function is simply to arrest the great part of the numbers of the light-waves, so that the intensity of their action is reduced. It matters not whether the long or the short waves are intercepted,<sup>1</sup> so enough of them are cut off to reduce the general average to a standard approaching that of diffused daylight, the normal stimulus of the eye. The indication is for a London smoked or dark-blue tinted lens, the depth of whose shade should be proportional to the nearness of approach and the intensity of the light.

As to the symptomatology of the ocular affection, there is the greatest unanimity in all the cases. If the light has been very intense and the exposure at short range, there will probably be a temporary "paralysis of the retina," lasting one minute or several, and accompanied by blepharospasm. There may be a blinding glare, positive and negative after-

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<sup>1</sup> See case β.

images, central scotomata, or other chromatic sensations, as of colored circles about objects, etc. In any case, what may be called the typical symptoms appear in from two to twenty-four hours after the exposure. There is then always photophobia (with blepharospasm) pronounced and intense. Lachrymation is always present, and the third unailing symptom is pain in the eyes, which, probably, also extends to the head. The intolerable ocular pains are usually accompanied by a feeling as of particles of sand under the lids, and these particles seem large, recognizably distinct, and unendurable. The conjunctiva, especially when exposed to the direct action of the light, is congested, usually intensely so; there is sclerotic hyperæmia, pericorneal circles, and myosis.<sup>1</sup> During the attack ophthalmoscopic examination is scarcely possible, and would probably show nothing of importance, since the symptoms are almost entirely those of a reflex neurosis, due to conjunctival irritation. The attack lasts from one to three, or even more, days, and may be cut short by the rational indicated treatment.

The prognosis is good; no case of permanent injury having been so far reported.

As to the treatment, a mydriatic should be used to set at rest the ciliary muscle, and cocaine to relieve the pain, the irritation, and reflex spasms of the muscles. Astringent collyria are wholly useless, and might prove injurious. Cold compresses have

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<sup>1</sup> I hardly understand how there could be mydriasis, as in one instance reported.

been usually employed, but I should use hot ones if a case were presented to me.

As regards the pathology of the affection, Nodier (7) ascribes the conjunctival hyperæmia to the retinal lesion by reflex action, that produces spasmodic contraction of the muscular fibres of the iris and ciliary body, whence results compression of the irido-choroidal venous trunks with venous stasis, or reflux, of these and of the conjunctival vessels. Nodier had not had any such experiences as those described in cases 12, 14, 22, 23, in which the skin of the face, neck, or hands was affected. Case 23 is particularly instructive, as showing that the conjunctiva was injured by the direct action of the light, and only where it was exposed to the same. Heimann<sup>1</sup> thinks the conjunctivitis (*sic*) is due to the pressure of the lids on the eye in the spasmodic action of the orbicularis under intense light. The whole matter seems simple enough and easily explicable. The fact that photophobia, lachrymation, pain, etc., are not symptoms of retinal lesions and inflammations, seems to make Nodier's assumptions purely gratuitous. These symptoms are the infallible results of irritation of the external tissues, the conjunctiva, cornea, etc. This irritation certainly exists in electric light injury: it affects all exposed parts, and is most intimate, penetrating, and severe. It simply results in vaso-motor paralysis by pure reflex action, and there follow as inevitable and necessary consequences the outflow of tears, the vascularization

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<sup>1</sup> Prager Vierteljahrsschr., Bd. 100, S. 200, 1868.

(not conjunctivitis) of the conjunctiva, etc., the blepharospasm, the photophobia, and the pain.

Summing up the conclusions reached, I should say that:

1. As regards general hygiene, the superiority of the electric light over gas as an artificial illuminant is so overwhelming as to admit of no discussion. It is incontestably the light of the future, and the public should not rest until its meeting-places, such as theatres, halls, reading-rooms, churches, etc., are lit by the most perfect system at its command.

2. A study of the published cases of injury of the eyes by the electric light shows that not one was due to the use of the diffused light as an illuminant.<sup>1</sup> The popular prejudice against such a use of it is absolutely without justification. All the cases reported were of scientific investigators, etc., or workmen about the light, who approached it very closely, gazed at it protractedly, and without protecting colored spectacles.

3. The ocular injury is due, not to the supposed preponderance in the electric-light rays of violet and ultra-violet (chemical or actinic) waves, but simply to the greater number (intensity) of the usual length light-waves.

4. The symptoms of the ocular injury are possibly

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<sup>1</sup> I have not alluded to a common complaint against the arc lamp that it is injurious because of its changeableness or flickering. This was and sometimes is exceedingly uncomfortable. With the rapid improvements being made, and especially with the improved Edison glow light, the complaint is fast becoming groundless.

immediate temporary "retinal paralysis," blepharospasm, central scotomata, chromatopsia, after-images, etc. Within twenty-four hours there come on intense photophobia, lachrymation, ocular pain, a feeling as of foreign bodies beneath the lids, conjunctival hyperæmia and congestion, pericorneal circles, etc.

5. The attack usually lasts but two or three days; the prognosis is excellent; the treatment is simply cocaine and atropine instillations and cold or hot compresses.

6. Workmen and experimenters who must approach closely to the electric light should protect their eyes by smoked or tinted glasses, the depth of the tint being greater where the light is more brilliant, the proximity greater, or the exposure longer. In the welding-works the workmen must be particularly careful about this, and must also not expose the skin of the face, neck, and hands to the action of the light. The precaution may not be amiss to advise the curious against testing their eyes by gazing at the ordinary arc and glow lights at short-range.

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3. *Cohn*: The Electric Light Analysis, in Brit. Med. Journ., vol. i. p. 743, May 17, 1879.
4. *Du-*

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<sup>1</sup> *Note*: It is rare that the Germans are caught napping, but I doubt if a single one of the above articles is indexed in Michel's Jahresbericht der Ophthalmologie.

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