evidence of variations in the lumen and in the state of the walls of the optic foramina is of considerable help, but negative findings are also of much service in diagnosis and treatment.

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INDUSTRIAL EYE INJURIES AND THEIR PREVENTION

BY

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THIS contribution is based on a study of patients who attended the casualty department of the Royal Eye Hospital, St. George's Circus, London. The hospital, situated in a highly industrialized area, is the only eye hospital south of the river. In the year 1935, 10,786 patients attended the casualty department of whom

approximately 6,500 were suffering from industrial eye injuries. In the first six months of 1936, the casualty department of the hospital attended to 5,623 patients; approximately 3,650 were suffering from industrial eye injuries.

All patients attending the casualty department are asked whether their injury was sustained at work, and a note of their statement is made in the hospital notes. Patients are also asked about the type of work they were doing at the time of the accident.

As a result of the latter investigations, one finds that about 50 per cent. of all industrial eye injuries were sustained by the men grinding on emery wheels. This type of work is responsible for the largest number of corneal foreign bodies seen at the hospital.

The following occupations:—(1) working on the lathe, (2) turning, (3) chipping, (4) milling, (5) spinning, (6) boring, (7) hammering, (8) soldering, (9) drilling, (10) chipping boilers, (11) electric welding, account for a further 30 per cent. of the eye injuries. Hammering and chipping caused the greatest number of intra-ocular foreign bodies.

The engineering and metal trades are therefore responsible for about 80 per cent. of all industrial eye injuries. The following trades account for the remaining 20 per cent.:—(1) building, (2) chemical factories, (3) coke making, (4) loading and transport, (5) paper factories and printing factories.

Types of Injuries

Corneal Foreign Bodies.—These form the bulk of industrial eye injuries. In the first six months of 1936, 2,700 patients attended for removal of corneal foreign bodies: Nearly 95 per cent. came from the metal and engineering trades. The patient often knows the time when the foreign body gets into his eye, but frequently he can only vaguely refer to it. Discomfort usually starts 6-12 hours later, after which "latent period" he begins to feel pricking when closing his eye, and in many cases he complains of photophobia when attending the hospital on the morning after the injury is sustained. This "latent period" may extend to several days, the patient coming up for treatment three or even ten days after injury. In many of these cases there is marked keratitis surrounding the corneal foreign body, but the cornea heals and clears surprisingly quickly after removal of a corneal foreign body.

The amount of irritation caused by the metallic foreign body depends in most cases on the degree of corneal rusting present. Iron rusts the cornea very rapidly, and in some patients, seen a

few hours after the accident, a great deal of rusting was already present.

Most corneal foreign bodies following industrial injuries are buried deep in the epithelium, and should be removed with a dissection needle. Many of our patients were attended by their doctors and by house surgeons in general hospitals who tried to remove the foreign body with a blunt instrument (a spud) and, after failing to do so, referred them to the Royal Eye Hospital. To remove a corneal foreign body it is essential to cocaine the eye, to have a good light, a loupe and a sharp dissection needle.

The ring of rust should be removed in every case, otherwise the eye will remain irritable. A mydriatic is instilled in each case, and a pad and bandage put on. These two facts are especially mentioned, because a great number of patients were seen who were treated at first outside the hospital, and the use of a mydriatic or pad and bandage was omitted.

It has been stated that the cornea gets less sensitive after repeated injuries (multiple corneal foreign bodies) and that this fact explains the late arrival of the patient for treatment. The sensitivity of the cornea of many of these patients was examined, and, in many cases, diminished sensitivity was established, but it was not found to be the rule.

Another observation made was, that the cornea of the younger workman was more sensitive than that of the man in the sixties, and that the diminished sensitivity did not depend on the number of previous corneal injuries. It was also noticed that the younger workman came up for treatment sooner than the older man.

Subtarsal Foreign Bodies.—These were remarkably rare in industrial cases—they were seen only in patients occupied in loading and transport trades. These patients sought advice at once, as the eye got sore immediately after the entry of the subtarsal foreign body.

Corneal Abrasions.—These form the next largest group of industrial eye injuries. In the first six months of 1936, 850 patients were treated in the casualty department suffering from corneal abrasions sustained at work.

Again the bulk came from steel trades.

Intra-ocular Foreign Bodies.—These should be thought of in all cases of industrial eye injuries. If the history of the patient points to a foreign body flying into the eye, a very careful search for the presence of a corneal or scleral wound should be made.

In all cases of doubt an X-ray examination is essential. In 1935, at the Royal Eye Hospital, there were 191 X-ray examinations for intra-ocular foreign bodies.

All patients suffering from an intra-ocular foreign body are admitted to the hospital, and the foreign body, if magnetic, is removed with the giant or hand magnet. In the first six months of 1936, 16 patients were treated for intra-ocular foreign bodies resulting from industrial accidents.

In 1935, 27 patients were admitted suffering from intra-ocular foreign bodies resulting from industrial accidents. Four eyes had to be excised. Thirteen patients developed traumatic cataract. Ten patients were discharged with vision 6/12 or better.

Perforating Eye Injuries.—Corneal and scleral wounds. In 1935, 22 patients were admitted with perforating eye injuries resulting from industrial accidents. Seven eyes had to be excised. Fifteen patients were discharged with vision 6/18 or better. In the first six months of 1936, 14 patients had perforating eye injuries

Chemical Burns.—These are comparatively rare. This may be explained by the fact that there are only a few chemical factories around the hospital. Approximately 50 patients were seen during the first six months of 1936 suffering from chemical burns of the conjunctiva or cornea. The chemicals which commonly caused the injury were, (1) sulphuric acid, (2) ammonia, (3) spirits of salts, (4) oxalic acid, (5) carbolic acid, (6) aniline dyes, (7) ink.

Lime, Concrete and Cement Eye Injuries.—Approximately 20 patients were seen during the first six months of 1936 suffering from burns of the conjunctiva or cornea caused by lime, concrete or cement.

In all cases of chemical burns the eye is thoroughly irrigated with a neutralizing solution or normal saline. The thorough wash-out of the conjunctival sac has been found to be of greater value than the neutralizing of the chemical. In cases of lime burns, 10 per cent. solution of neutral ammonium tartrate is used for irrigation, 15 per cent. solution of glucose is used in other eye hospitals.

Electric Welding Conjunctivitis (Photophthalmia).—There were approximately 30 cases of electric welding conjunctivitis in the first six months of 1936. In nearly all cases the patients either omitted to use the goggles provided or kept putting their heads at the side of the protective screen.

These patients develop symptoms about six or eight hours afterwards, and come up in many cases to the hospital in the very early hours of the morning complaining of pain, burning of their eyes and photophobia. They have a marked conjunctival injection, and in some cases show ciliary injection and superficial corneal staining. The best treatment for them is instillation of paroline

and covering their eyes with a pad and bandage for 24 hours. Most of them clear up after one or two days.

Some patients are constantly engaged in electric welding, and they come up to the hospital on many occasions with acute conjunctivitis following exposure to the arc, and in many cases a condition of chronic conjunctivitis develops.

Complications.—All patients seen in the casualty department are asked to report on the following day in the out-patients' department. Corneal abrasions and burns caused in metal and engineering trades heal very rapidly. It is most gratifying to see a cornea, which stained 24 hours previously over $\frac{1}{2}$ of its area, looking perfectly normal, and the eye presenting only a little ciliary injection.

Abrasions caused by wood, paper, concrete or cement are usually a source of greater trouble; infection may follow, and corneal ulceration, hypopyon ulcer and iridocyclitis develop in some of these patients.

Lime and chemical burns cause a good deal of corneal staining and the eye to remain irritable for several days.

Patients who had corneal foreign bodies are carefully examined on the following day for the presence of any rust remains. If rust was left, its removal is essential. A mydriatic and a pad and bandage are ordered as long as staining of the cornea continues. These simple facts are stressed because they are so often neglected by practitioners who are not used to treatment of eye injuries.

The vast majority of patients are left with no corneal scars, but there is still a great number whose convalescence after a corneal abrasion or removal of a foreign body is protracted, and superficial corneal scarring follows. The degree of scarring depends on the depth of the corneal foreign body, and the amount of rusting associated with it. Some patients have old central scarring which has reduced their vision to 6/24 or 6/18.

It is striking to note that a number of patients have attended the hospital during the last 4 or 5 years for removal of 24 or more corneal foreign bodies.

As a result of enquiries as to absence from work, it was ascertained that the majority of patients stayed away from work for a whole day, others for two, three, seven or more days. It was noticed that, if the cornea did not heal up within three days, the absence of the patients from work extended to a week or longer.

The extent of serious complications following industrial eye injuries can be gauged by the number of admissions of these patients to the hospital. In 1935, 70 patients were treated as in-patients suffering from industrial eye injuries. Approximately 40 were sent for treatment as in-patients to L.C.C. hospitals in view

of the shortage of beds at the Royal Eye Hospital. The total number of in-patients at the Hospital in 1935 was 968.

In the first six months of 1936, 37 patients were treated as in-patients following industrial injuries, 27 patients were sent for treatment to L.C.C. hospitals. The total number of in-patients for the first six months of 1936 was 455.

The industrial cases therefore represent over 10 per cent. of all in-patients of the hospital. The admissions in 1935 were, as already stated above, 27 patients with intra-ocular foreign bodies, 22 with perforating eye injuries, the other 61 patients were suffering from severe cuts of the cornea, infected abrasions, hypopyon ulcers, iridocyclitis, burns or chemical burns. One patient developed sympathetic ophthalmitis.

This report does not pretend to give a general survey of industrial eye injuries. It simply deals with injuries as seen at a London hospital serving a large industrial area of London, and it can be taken as representing the type of industrial eye injuries met with in the London area.

The Extent of Industrial Eye Injuries

The annual report of the Chief Inspector of Factories and Workshops for the year 1934, published by His Majesty's Stationery Office, gives the following figures: Total non-fatal accidents in 1934, 136,073; total eye injuries, 5,950. The annual report only refers to accidents which disabled the workman for more than three days from earning full wages for the work at which he was employed. The total 5,950 for 1934 only represents an extremely small number of the multitude of industrial eye injuries in this country per annum. The bulk of eye injuries cause the workman to lose his wages for one, two or three days, and would thus not be reported in the Chief Inspector of Factories' report.

The economic loss to the workmen and the country is tremendous, and its extent can only be gathered from a hospital report as given above, which conveys a true impression of the numbers of industrial eye injuries in a certain industrial area.

American insurance statistics¹ show that in terms of workmen's compensation the eye hazards of industry are more serious than any other group of accident hazards with the single exception of those resulting in death. More money is paid by employers each year in compensation for eye injuries than is paid for injuries to any other part of the body. Lewis H. Carris² writes that the employers of New York State are on the whole as progressive as any in America in the matter of accident prevention; nevertheless, an

analysis of eye injuries during the last six years prepared for the National Society for the Prevention of Blindness by Dr. E. B. Patten of the New York State Department of Labour shows a more or less steady increase in the number of permanent total disability and permanent partial disability cases from 2,247 in 1925 to 3,200 in 1930.

In this country, the annual report for 1930 shows that there were 6,256 eye injuries out of a total of 144,758 industrial accidents; in 1931 there were 4,807 eye injuries out of a total of 113,249; in 1932 there were 4,433 eye injuries out of a total of 105,562; in 1933 there were 4,540 eye injuries out of a total of 112,512. The year 1934 shows an increase in the incidence of eye injuries.

The Departmental Committee on the Causes and Prevention of Blindness set up by the Ministry of Health gave in its report in 1922 most instructive figures for this country. Mr. McBride, of the Commercial Union Assurance Company, gave the Committee statistics of claims made on accident insurance companies.

The statistics relate to 111,000 claims, of which 2,585, or 2·33 per cent. were in respect of eye accidents.

Investigation was made by the Committee of records of eye accidents at hospitals in London, Manchester, Newcastle, Glasgow and Edinburgh. Out of 3,700 records examined of in-patient eye accidents, 2,336 were recorded as industrial accidents.

These two sets of statistics indicate in how large a number of occupations eye accidents occur, and point out that the greatest quantity of accidents occurs in mines and quarries and the large group of industries forming the metal and engineering trades.

The report also gave the figures of blindness as furnished by the Scottish Board of Health, showing that, on the Scottish Register of the Blind in 1922, there were 5,515 blind persons, 426, or 7·2 per cent. of whom were blind as a result of industrial eye injuries. The figures for England and Wales were not available for the Committee. The American figures¹ show that 15 per cent. of the blind of America lost their sight following industrial injuries. The American insurance and blindness figures are easily obtainable. In this country, insurance figures are treated as a confidential matter, and I could not obtain any information in answer to my enquiries.

The records of the State Department of Labour and Industry of Pennsylvania² show that, in 1927, 288 eyes were lost, in 1929, 565 eyes were lost and in 1930, 520 eyes were lost as a result of industrial eye injuries. The amount of compensation paid out for these and other serious eye injuries was one million dollars per annum.

Prevention of Eye Injuries

A recent analysis of circumstances surrounding 70,000 accidents has led Heinrich, of the Travellers' Insurance Company, to the conclusion that 98 per cent. of all industrial accidents are preventable, and of these 88 per cent. could be prevented by proper supervision and administration. These findings are corroborated by practical results achieved in large industrial undertakings in this country where great efforts are made in the prevention of industrial injuries.

The present high numbers are due to (1) non-provision of safety measures by employers and (2) the attitude of indifference shown by workmen to the risks entailed in their work, and their negligence in using preventive measures supplied to them.

The Committee on the Causes and Prevention of Blindness in 1922 recommended that all possible steps should be taken to encourage the Development of Works and Safety Committees with regard to the prevention of accidents, the use of safety devices and methods of propaganda, among which, questions relating to the eyes would have their place. The Home Office, in its annual report, 1934, tells about the establishment of Safety Committees all over the country, and the fine record achieved by safety organisations: for instance, at the Great Western Railway works, the wearing of goggles is made compulsory in certain operations such as, chipping, cutting of bolts, and processes of a similar nature. In other operations, where there is any risk of injury to the eyes, the members of the staff are encouraged to wear goggles. The chief engineer of the works at Swindon gives me permission to state that in the whole of his department during 1935, only two eye injuries were recorded in cases where goggles were being worn and, in one of these instances, the man concerned was absent from duty for one day only.

As a result of inquiries of workmen attending the Royal Eye Hospital, one can state that a multitude of firms, especially small firms, have, unfortunately, no safety organisations.

Safety devices have increased very rapidly since 1922. They can be divided into two types. (1) Goggles, masks, veils, eye-screens. (2) Screens and guards attached to machines.

The Home Office Industrial Museum, Horseferry Road, Westminster, has a most complete exhibition of preventive measures used in industry to safeguard the eyes in various operations. With the Chief Inspector of Factories' kind permission, some safety devices exhibited in the Museum are described.

The first stand shows different types of protective measures used by workmen in various trades.

(1) Goggles for acetylene and electro-welders. These are fitted with dark lenses of various shades depending on the type of welding done and amperage used

(2) Goggles for men engaged in lime works as used by the Associated Portland Cement Manufacturers.

(3) A mask worn by rollermen in steel works. This mask protects the eyes and face from pieces of hot scale, and is used by Port Talbot Steel Works, Glamorganshire.

(4) Goggles to protect the eyes from fumes of gas.

(5) A fine silk veil to be used in metal trades as a protection against fine metallic chips.

(6) Goggles made of fine wire gauze used for protection against heavy chips of flying material; also used by persons at chipping paint from metal work on bridges.

(7) Unbreakable goggles for use by workers in the iron trades. The large glasses provide a wide field of vision. This type is encouraged by the Iron Trades Employers' Insurance Association.

(8) An eye screen designed to meet objections raised to the use of goggles. "The screen is very light and comfortable to the wearer. It offers very little restriction to the field of vision. The material 'Bentine' is non-inflammable, and will withstand a blow of some severity."

(9) Many other types of goggles for protection in glass and electric bulb works, etc.

The use of screens on machines forms the subject of the other stand of exhibits. Here are photographs showing (1) the use of screens for brass working machines. "In the machining of brass articles the cutting is done at a fairly high speed, and the chips of metal which are often quite hot are projected from the tool with some violence. The use of a screen between the tools and the operator prevents eye injuries and small burns on the operator's hands and arms." (2) A photograph of grindstones provided with a celluloid screen.

The use of such screens on emery wheels would prevent a great number of eye injuries; they are especially suitable for works where occasional grinding of tools is done by the workmen. The use of goggles is always neglected, and the screen acts as a very efficient protection against small flying particles of emery or steel.

Such screens are used at the London Passenger Transport works, and they have greatly diminished the incidence of eye injuries.

There is also shown a model of a grindstone fitted with a triplex screen. This "clearview" grinding wheel guard offers complete protection and renders the use of goggles unnecessary. Its cost is

not high, and it can be fitted to any convenient position on the grinder head.

All those safety measures shown at the Museum are actually in use in a number of industrial establishments all over the country. The goggles shown in the Museum have overcome the usual complaints brought by the workmen against their use. (1) They can be fitted comfortably. (2) They are light. (3) They do not impede vision. (4) They can be used with an "anti-dimming" compound which prevents condensation of moisture on the lenses.

The workmen are most reluctant to wear goggles, and even those who have had several corneal injuries will not put their goggles on while grinding or turning, and it will require a great deal of propaganda work on the part of safety organisations to break the old prejudices and habits of the workmen. In the United States of America some accident insurance companies make a reduction in premium to those employers in whose works safety committees have been put into operation. The Committee for Prevention of Blindness (1922) recommended that similar facilities should be given by insurance companies in this country.

This recommendation of the committee is still just as urgent as it was 14 years ago when the Committee published its report. The problem is too wide to be tackled by individual employers and local safety committees.

If the insurance companies will join in the excellent work done by some employers of labour and many safety organisations all over the country, we will achieve a diminution of eye injuries and, with it, of its resultant total or partial blindness.

I wish to thank all the members of the staff of the Royal Eye Hospital for their kind permission to publish the casualty and in-patient figures of the hospital, and also for their help and advice in preparing this report. I must also acknowledge my gratitude to Dr. J. Bridge, Senior Medical Inspector of Factories of the Home Office, for the kind assistance he has lent me. Also to all the members of the administrative and nursing staff of the Royal Eye Hospital who helped me to collect the figures of patients given in this report.

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