NON-PERFORATING INJURIES OF THE EYEBALL.

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The incidence of eye injuries has increased considerably in the wars of the last 50 years. In the Chino-Japanese War of 1894 the figure was 1.2 per cent. of all wounds. During the Spanish-American War, the Boer War and the Russo-Japanese War there was a slight increase in which 92.2 per cent. of the eye wounds was due to firearms, 3.8 per cent. to the sword and bayonet, and in 8.5 per cent. of head wounds the eyes were involved. In the 1914-18 European War the incidence of eye wounds rose to 8 per cent. of all injuries, due to the relatively greater exposure of the head in trench warfare and to the indirect damage done by the concussion of high explosives used to blast soldiers out of defensive positions and to the spraying of the eyes with minute fragments of sand and earth when explosives burst on trench parapets. Indirect eye injuries accounted for 6 per cent. of all battle casualties. It is remarkable that the eye which is $1/375$ of the body surface should be relatively so vulnerable. It is probable that its exposure and the fact that it may be seriously injured by small flying particles which would pass unnoticed if embedded in the skin or be stopped by clothing, may account in some measure for this.

The steel helmet and the vizor (a recent pattern of which has been designed by Sir Richard Cruise) should reduce the incidence of eye injuries among troops defending fortresses and trenches, except in the case of large rapidly moving missiles. The cellulose acetate eye shield and the 4 mm. thick non-splinterable lenses of the service respirator would protect the eyes from flying particles of sand and earth.

Chemical Warfare. Gases.

The likelihood of poison gases, so called, being used is at the present stage of this war difficult to forecast. It is significant that Germany before her annexation of Czecho-Slovakia produced 145,000 tons of such chemicals and that the Franco-British dye industry has recently made 80,000. One of the best books on chemical warfare has been written by Sartori of Milan.

The use of poison gases is dependent upon meteorological factors, the state of the terrain and tactical necessity of the commander. They may be employed to place certain ground out of action whilst an attack is developed elsewhere; in combination with smoke masking attacks on fortresses; as a harassing agent and for the purpose of putting large bodies of troops out of action when concentrated as reinforcements behind the front line.

The ethics of chemical warfare has not yet been clarified.

The chemists are of opinion that no further advance is likely to occur from their aspect of the subject, but it is possible that some physical alterations may increase the toxicity of the present known gases.

All the gases used in modern war have an effect on the eyes, but of these only two, mustard and lewisite, are known to produce serious ocular lesions. The lachrymators (i) *ethylchloroacetate* "K.S.K." (ii) *bromobenzylcyanide* "B.B.C." and (iii) *chloroacetophenone* "C.A.P." cause in concentration immediate irritation of the eyes, a stinging sensation and a profuse lachrymation. In the higher concentrations blepharospasm is evident. The conjunctiva is infected and swollen, but there is no involvement of the cornea. These ocular symptoms disappear

in a few hours, the eyes respond well to treatment by lavage with simple lotions and there is no residual neurasthenia.

The sensory irritants—arsenical compounds, the asphyxiants, phosgene and chlorine, and the "smokes" also cause mild conjunctivitis.

Mustard may be used as a spray from aeroplanes, in shells, bombs, mortars and grenades. Lewisite, β -chlorovinyl dichloroarsine, which is similar to it in some respects was not used in the 1914–18 war but may be employed in the present conflict. The arsenic in it is a systemic poison, is absorbed through the skin and lungs and has been recovered from the urine and tissues of experimental animals. Lewisite is more rapidly irritant than mustard, has an early sensory irritant action and the eye symptoms are therefore more severe.

Ocular Protection.

Against these poison gases the soldier has his service respirator, the eye pieces of which are made of non-splinterable glass 4 mm. thick, the head piece is air-tight and that together with the box filter gives him secure protection against mustard and lewisite vapour.

In the forward areas he must wear an eye shield made of cellulose acetate which protects his eyes from droplets and splashes of liquid mustard.

Mustard Gas.

Mustard gas is a severe chemical irritant to living tissues with which it forms highly toxic by-products of disintegration. It has been suggested that it combines with the free amine groups of the protein molecules and forms a stable toxic substance. With rare exceptions the reaction of a minute drop of mustard oil 0.004 c.c. on the eyes of man and experimental animals is followed by an immediate, intense and rapid reaction which seems to be quite unaffected at this stage by any local treatment known up to the present. A small per centage of experimental animals appear to have some degree of natural resistance and it is thought that they present a tissue barrier to liquid mustard.

Mustard possesses a degree of liposolubility but is relatively insoluble in water; at 10° C. this is 0.07 per cent., and at body temperature 25 per cent. of mustard in such a solution is hydrolysed in 3 minutes. This reaction is not accelerated by alkalis. It is, however, doubtful if hydrolysis in the conjunctival sac plays much part in reducing the severity of the lesion. Mustard is more readily absorbed by the cornea than by the skin. Except for its peculiar and specific intracellular reaction it is not an active substance chemically.

Mustard vapour in as low a concentration as 1/10,000,000 in air produces ocular symptoms and signs after a delay varying from 2 to 48 hours; in the majority of cases these occur 6 to 8 hours after exposure, but with the more concentrated vapour the effect is immediate.

The interaction of mustard with the secretions of the eye causes an alteration which leaves the mustard inactive as such 15 minutes after it has entered the conjunctival sac. The instillation of such secretions into the eye of an experimental animal is without effect. After the initial reaction an oxidation process probably occurs.

Symptoms and Signs.

The severity of the ocular injury depends on the concentration and the length of time of exposure to the gas. The action of mustard may be cumulative and with the modern methods of liberation the proportion of severe cases will probably

be increased. The ocular injury caused by mustard is slowly progressive and in the more severe burns there is a marked delay in healing analogous to an X-ray burn.

(i) Ocular Injury from Mustard Vapour.

(a). **Cornea not visibly affected.** There is a sense of grittiness under the lids and pain in and around the eyes. Photophobia, blepharospasm and lachrymation follow. In the slight or moderately severe cases the bulbar conjunctival vessels in the interpalpebral zone are congested and the conjunctiva is swollen.

Functional photophobia may persist after all inflammatory signs have disappeared and an anxiety state and fear of blindness may delay convalescence. In the 1914-18 war about 75 per cent. of the mild cases returned to duty in 1-4 weeks and in 15 per cent. of moderately severe cases in which there was no corneal damage there was recovery in 4-6 weeks.

(b) **Cornea appreciably damaged.** In these cases photophobia, blepharospasm and lachrymation were severe. The interpalpebral zone of the bulbar conjunctiva was white from a coagulated exudate, the pressure of which had obliterated the capillaries. Above and below this chemotic conjunctiva bulged forward from the fornices. The lids became swollen, red and adherent with sticky discharge and crusts. Across the cornea there was a wide band-like opacity continuous with the whitened interpalpebral bulbar conjunctiva.

The cornea was stippled ("orange-skin"), the corneal reflex was irregular, the corneal epithelium oedematous and roughened, later it became exfoliated and there was diminished corneal sensation which persisted for weeks. The pupil was constricted as a result of irritation.

Secondary infection from pyogenic micro-organisms, corneal ulceration, hypopyon and panophthalmitis are complications which may follow within 4 or 5 days of the injury and have to be guarded against as far as possible. Chest complications may reduce the reparative process. A neurasthenic state may complicate the convalescence and must be obviated by encouraging the patient and affording him opportunities for useful physical and mental occupations.

These severe cases amounted to about 10 per cent. They were under treatment for 2-4 months before returning to duty and 10-14 years later some of them have broken down with recurrent corneal ulceration leading to increased corneal scarring, irregular astigmatism and reduction in vision.

(ii) Ocular Injury from Mustard Oil Drops.

The effect of a minute drop of mustard splashed into an eye is an intensification of the above symptoms within a few seconds of the accident. Loss of corneal epithelium and spreading keratitis occur. Symblepharon, secondary infection with pyogenic micro-organisms, hypopyon and panophthalmitis are complications.

The residual signs of mustard gas injury to an eye are dilated, tortuous, varicose, dark-coloured conjunctival vessels in the interpalpebral zone 3 or 4 mm. adjacent to the limbus. These vessels show calibre irregularity and are embedded in a greyish-white matrix of scar tissue. The appearance is "marble" like. It is probable that some impairment of blood supply at this site affects the cornea, the sensation of which is impaired in some cases. Greyish opacities are present in the cornea and these cause irregular astigmatism and reduction in visual acuity when near the centre. Recurrent corneal ulceration occurs in some of these cases.

Macroscopic and microscopic changes in the cornea of experimental rabbits. The corneal area affected by a drop of mustard oil stains deeply with fluorescein in 5 minutes. Destruction of the corneal epithelium and Bowman's membrane is immediate. Five to 10 minutes after the injury photophobia is evident and a fine corneal haze appears around the affected site. Then fine superficial epithelial linear striæ are to be seen and these form a transverse bar and ultimately are disposed in a cobweb pattern.

Twenty-four hours later the site stains deeply with fluorescein, there is dense oedema, the fine cobweb is masked by deeper changes and the area staining with fluorescein is 4 or 5 times the size of the primary site. There is a white thick mucoïd discharge and the pupil contracts as a result of irritation in one-third of the cases.

After 48 hours there is deep keratitis and in 4 days the discharge is profuse causing adhesion of the lid margins and thick crusts. Secondary infection with micro-organisms occurs and unless the eye receives appropriate local treatment it becomes disorganized and lost in 6 weeks.

Fine staining of a branching character is seen 4 days after the injury and there is membranous conjunctivitis. Other complications are ectropion and contraction of the lids, linear scarring and notching of the lid margins in 3 or 4 places, hypopyon ulcer, panophthalmitis, large leucoma, staphyloma and general disintegration of the eye.

Histologically the following changes are evident. The superficial cells are desquamated; the healing epithelium is thinner than normal; Bowman's membrane, the lamellæ of the substantia propria and the corneal corpuscles show cloudy swelling; there is nuclear chromatolysis and later fragmentation into dark staining spherules. There is early eosinophil invasion, albuminous exudate in the anterior chamber of severe cases and the affected area of the cornea is thicker than normal.

Treatment.

Colonel Poole has instilled liquid mustard into both eyes of an experimental animal. One eye was irrigated immediately and thoroughly and the other eye was left untouched by treatment. Next day the macroscopic appearances of the lesions were indistinguishable.

It seems therefore that immediate local treatment is of little avail in cases where the eyes have been damaged by mustard droplets or highly concentrated vapour.

Livingston and Walker have produced some experimental evidence to show that in rabbits the intravenous injection of ascorbic acid prevented the spread of keratitis and the progress of lid inflammation when administered 20 minutes before a mustard oil droplet was applied to the cornea and subsequently for 6 daily injections. At first the dose advocated was 500 mgm. but recent work has suggested that 100 mgm. may be sufficient. With this treatment the corneal changes appeared to be milder and there was no secondary infection with pyogenic micro-organisms. Ascorbic acid belongs to the group redox potentials, which maintain a fine balance between processes of reduction and oxidation by acting either as reducing or oxidising agents, whichever action is called for. Livingston and Walker thought that ascorbic acid might operate by inhibiting or preventing the interaction between mustard and the corneal tissues and the production of the

stable toxic substance which causes the spreading keratitis and corneal tissue destruction. Ascorbic acid is non-toxic, and it is present normally in the cornea and the lens.

At present there seems to be no more satisfactory lotion for irrigating the eyes, removing desquamated cells and discharges than sodium bicarbonate 2 per cent., pH 8.0. Bonnefont recommends a solution of saturated sodium sulphate 800 grams and sugar syrup 200 grams, pH 7.0. There is not an adequate scientific basis for Bonnefont's claims and the indication of further corneal oedema by employing such a hypertonic solution is doubtful. Down Bros. have made a self-retaining irrigating speculum which allows the interpalpebral aperture to be opened to about one-third of its normal extent and streams of lukewarm lotion to be directed into the upper and lower fornices and over the cornea.

The micro-organisms of secondary infection are evident in some cases between the fifth and eighth days. Livingston and Walker recommend the use of merthiolate 1/10,000 with a diffusing factor and found that the optimum period of value was 5 to 7 days. If merthiolate drops were used after this ocular congestion recurred.

Cod liver oil drops with or without vitamin A are of value in assisting corneal regeneration and checking keratitis. These drops require no sterilization.

Warthin and Weller claim that dichloramine T 0.5 per cent. in chlorcosane (chlorinated medicinal paraffin) is of value in dealing with secondary infection with pyogenic organisms. Such a solution is only stable for 3 days and should not be used if there is a precipitate.

Atropine or hyoscine are necessary when the cornea is involved.

Some years after mustard gas injury with corneal damage the incidence of recurrent corneal ulceration may be reduced, the patient rendered more comfortable and his cornea protected by the use of contact glasses filled with ol. parolein and applied to the eyes. These glasses also correct any irregular astigmatism and thereby improve the vision appreciably.

The German first-aid treatment consists in irrigation with saturated boric acid, the application of sodium bicarbonate ointment and the use of pilocarpine drops and pituitary extract. Saturated boric acid is more irritating than sodium bicarbonate.

Although early local eye treatment of the injured men in the field may be of little avail in saving corneal tissue already badly damaged an attempt to do a simple irrigation, to instil pantocain (local anæsthetic drops which do not damage the corneal epithelium as cocaine does nor delay its regeneration) and cod liver oil drops into the eyes, and to provide clear tinted eye-shields may help to prevent panic among the casualties whose swollen and adherent lids often lead them to imagine that they are blinded. The sight of injured men without attention and obviously distressed has a demoralizing effect on troops moving forward. The above treatment may be given by means of an improvised field irrigator.

An irrigator is improvised by taking an empty 2 gallon petrol tin, boring 4 holes in its bottom, each sufficient in size to admit the base of a discharged bullet case, the cap of which has been perforated. The bases of these 4 bullet cases are soldered into the tin making water-tight junctions. The whole tin is cleaned and sterilized. To the projecting extremities of the bullet cases $4\frac{1}{2}$ feet of rubber tubing is attached and into the free ends of these are inserted metal irrigator nozzles each with a lever switch control to cause or stop the flow of lotion. The tin is suspended from a 6 foot wooden stake driven into the ground and each of the 4 irrigator tubes is operated by an orderly.

A suitable quantity of sodium bicarbonate is carried by the unit and with boiled water it is made up into a 2 per cent. solution.

Allowing 3 minutes for the treatment of both eyes ($1\frac{1}{2}$ minutes each eye) 1 team of orderlies with 1 irrigator could treat 80 men in 1 hour, 2 teams 160, 3 teams 240 in 1 hour and so on.

In heavily contaminated cases the personnel carrying out the treatment will have to work in anti-gas clothing and respirators and the wounded pass through a decontamination and cleansing centre.

In the advanced areas badly injured men may be led in files, connected by ropes or sticks, by a sighted guide from the field ambulance.

A painting by Sargent is hung in the Imperial War Museum, London, of a typical scene at one of the dressing stations in France, 1915-18. In the early days of chemical warfare the eyes were bandaged, as shown in the picture. It was appreciated later that this should never be done in the case of patients suffering from mustard gas injury to the eyes.

Neurasthenic symptoms, blepharospasm, photophobia, anxiety states and fear of blindness require appropriate attention during convalescence. An atmosphere of cheerful optimism should be emanated by those taking charge of these cases. Games and gradual rehabilitation help to reassure the patient and to restore his confidence and hope.

It is probable that if mustard gas is used in the present war a number of new therapeutic agents will be tried out. The French eye surgeons favour methylene blue 0.5 per cent. and scarlet red 3 per cent. to deal with non-specific infections. The use of tarsorrhaphy at an appropriate stage may prove to be of value in preventing or reducing the incidence of late attacks of recurrent corneal erosion.

The use of ascorbic acid intravenously must await trial on human patients before any definite opinion can be given about its value.

Contusions and Concussions.

The eye lesions caused by missiles which do not perforate its tunics vary from a minute corneal abrasion or impaction of a small foreign body to rupture of the sclera or cornea and considerable disorganization of the globe.

Foreign Bodies.

The impaction of foreign bodies composed of sand, earth, steel, copper and iron fragments, glass and stone often affects both eyes and the foreign bodies are multiple. Those which are accessible are removed as early as possible under pantocain 1 per cent. surface anaesthesia. Fragments projecting into the anterior chamber may be removed by passing into the aqueous a Lang's knife followed after its withdrawal by a spatula curved to the posterior aspect of the cornea and made exactly to fit the knife incision thereby preserving the aqueous from seeping out. The foreign body is removed by cutting down with a fine needle on to the spatula which presses the foreign body forward and then by lifting it out through the corneal incision. A foreign body embedded in the sclera must be approached by fashioning a conjunctival flap in its vicinity, turning it back, then lifting the foreign body out of the sclera with a spud or curved needle and suturing the conjunctival flap over the wound. If perforation and not penetration of the sclera is suspected, scleral sutures should be applied before removing the foreign body and instruments should be ready for abscission of prolapsed uveal tract and any necessary wound toilet.

Multiple small foreign bodies deep in the substantia propria are best left untouched if they give rise to no inflammatory reaction and cause no pain.

The presence of ciliary infection and extensive corneal damage necessitates the administration of atropine 1 per cent. twice or thrice daily; the application of heat by diathermy, electrically heated eye pads or hot bathings; dark glasses and occlusion with a pad and bandage when the cornea is abraded. A pad and bandage should not be used if there is conjunctival muco-purulent discharge.

All foreign bodies projecting from the palpebral conjunctiva and the skin surfaces of the lids should be removed, also those deep in the substance of the lids around which infection with pyogenic micro-organisms has occurred. Multiple fragments of gunpowder and other foreign matter which is quiescent may be left untouched surgically.

Corneal Abrasion.

Abrasions affecting two-thirds the size of the corneal epithelium and superficial abrasions uncomplicated by infecting micro-organisms may heal completely in 48 hours after gentle cleansing with a lukewarm normal saline irrigation, the instillation of ol. parolein or cod liver oil drops and the application of a firm pad and bandage. In such a case there will be no residual scar provided that Bowman's membrane has not been damaged. Where the deeper layers of the cornea have been injured and destroyed and when infection by pyogenic micro-organisms has occurred the residual scarring may reduce the visual acuity, if it is near the centre of the cornea, and cause irregular astigmatism. Recurrent corneal erosions may be a sequel due to the failure of the deeper layers of the regenerated corneal epithelium to become securely attached to Bowman's membrane. Curettage of the loose epithelium, the application of carbolic to the edge or chauffage, and a pad and bandage, may be necessary. Ol. parolein should be instilled into the eye every night for a few months to prevent the palpebral conjunctiva from adhering to the corneal epithelium.

Ocular damage by "windage" is disputed by some authorities. In the Official History of the War, Surgery, Vol. II, there is described the case of a soldier who was injured by a bullet traversing his nose and in its course searing the upper lid margin but causing no direct damage to the cornea. Opposite to the site of the injury to the lids the cornea became grey and infiltrated, a striate keratitis developed and the iris was inactive below this site for over a week.

As a result of an explosion the upper lid may be torn vertically without being struck directly by a flying particle. Fig. 5 is a drawing of the upper lid of a young officer who was injured by an accidental anti-tank mine explosion in France on December 16, 1939. There were no particles of gunpowder or other foreign matter embedded in his cornea which showed a moderately dense opacity occupying and extending beyond the pupillary area. Grey and black foreign matter was impacted in the bulbar conjunctiva and the subconjunctival tissues above and on the nasal side, and the lids were also considerably spattered.

Iris and Ciliary Body.

Rupture of the pupil margin, often with a radial tear into the sphincter iridis muscle may follow a blow from a blunt object or concussion. It is important not to use a mydriatic in the treatment of these cases. Iridodialysis in severe cases when a loose bridge of iris occludes the pupil may necessitate surgical intervention, an attempt being made to stitch the iris root into the filtration angle. The intra-ocular pressure must always be carefully watched after this procedure. Partial or

complete retroflexion of the iris and cyclodialysis are often complications; the former may be rectified at the time of operating on a traumatic cataract also the result of the same injury.

Lens.

Vossius's ring, concussion cataract, rupture of the fibres of the suspensory ligament with partial or complete dislocation of the lens are sequels to a blow on the eye or concussion in its vicinity.

Retina and Choroid.

The choroid may be split by the force of an explosion or the concussion effect of a bullet traversing the orbit behind the globe without actually touching it. These choroidal ruptures may be single but are often multiple and are concentric with and radial to the optic disc. The split may extend into the outer layers of the retina and so cause a sector-shaped scotoma. Hæmorrhage and exudate are frequently evident along the edges of the rupture.

At the macula a localized oedema which fails to absorb may lead to cyst formation between the inner and outer limiting membranes, the inner limiting membrane rupturing in some instances and thereby causing a well-defined circular excavation the floor of which is a crimson colour stippled with fine dots of brown pigment.

Following the passage of a missile through the orbit there occurs on the side of the impact, or on the opposite side of the fundus, or at the macula, large areas of dark red hæmorrhage and glistening white areas.

Fig. 6 is a drawing of the left fundus of the officer whose case is partly described above. The main force of the exploding anti-tank mine took him on the left side. There was a vitreous hæmorrhage which on absorption revealed large, deep crimson retinal and choroidal hæmorrhages, numerous small splits in the choroid, pigmentary disturbance and the dense white area fringed with pigment in the upper part of the fundus. The macula shows no ophthalmoscopic evidence of damage and the optic nerve is slightly pale.

The treatment of the fundus lesions consists in rest in bed, atropine, dark glasses and such time-honoured therapeutic procedures as hot vapour baths, potassium iodide and mercury inunctions, applied with the object of aiding absorption of the hæmorrhages and exudates.

Retinal tears and subsequent retinal detachment have been noted. Appropriate surgical treatment by surgical diathermy is necessary.

Optic Nerve.

Evulsion of the optic nerve may be caused by large missiles, spent shrapnel, fragments of shell and several bullets entering the orbit.

The concussion changes in the eye may indicate exactly the track of a missile and thus assist the general surgeon when there is some associated head injury. In fractures involving the optic foramen and canal bone fragments may lacerate or completely sever the optic nerve.

Sclera.

Missiles traversing the orbit without striking the eye may produce ruptures on the opposite side to the point of impact. For instance a missile on the temporal side caused a large equatorial rupture on the nasal side and another traversing the back of the orbit led to a corneal rupture which extended into the anterior part of the sclera.

PLATE I.

Mr. H. B. Stallard - - - - - Non-Perforating Injuries of Eyeball

Fig. 1.—Severe burn in acute stage.

Fig. 2.—Severe burn complicated with hypopyon ulcer.

Fig. 3.—Stage of resolution in mustard gas injury to the eye, showing absorption of coagulative exudate. Cornea has recovered its lustre.

Fig. 4.—Stage of convalescence.

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PLATE II.

Mr. H. B. Stallard - - - - - Non-Perforating Injuries of Eyeball

FIG. 5—A drawing of the left eye, lids and supra-orbital region of a young officer who sustained an injury from the explosion of an anti-tank mine. Note the vertical split in the upper lid and the scars radiating from this at its apex and on the temporal side. The small, irregular, dark patches are gunpowder and earth impregnated in the skin and subcutaneous tissues.

FIG. 6—Drawing of left fundus of an officer injured by an anti-tank mine explosion.

- a. Dense white area fringed with pigment.
- b. Pale zone showing irregular deposits of pigment and multiple minute splits in the choroid.
- c. Irregular shaped pigment deposits around the optic disc.
- d. Mass of greyish white exudate.

The common site of scleral rupture when the eye is struck from the front by a blunt object is in the upper nasal quadrant about 3 mm. behind and concentric with the limbus. Increased depth of the anterior chamber and lowered intra-ocular pressure are associated signs of rupture of the globe. Dislocation and even extrusion of the lens, prolapse of vitreous and the uveal tract and intra-ocular hæmorrhage are complications in some cases. In many cases it is worth while attempting some conservative surgery by turning back an adjacent conjunctival flap, placing atraumatic eye-less sutures in the edges of the scleral wound, performing wound toilet with abscission or replacement of any prolapsed intra-ocular structure, closing the wound by tying the scleral sutures and covering it with the conjunctival flap.

Intra-Ocular Hæmorrhage.

Following contusion or concussion of the eye hæmorrhage may take place into the anterior chamber, the vitreous, retina, choroid, beneath the hyaloid membrane, between the layer of rods and cones and the retinal pigment epithelium and in the supra-choroidal lymph space.

If a hyphæma is total, or nearly so, and is causing secondary glaucoma and blood staining of the cornea it should be evacuated by paracentesis and wash out of the anterior chamber. Generally the blood enters the anterior iris crypts and is absorbed by the stroma.

In the 1914-18 European War one case of blood entering the lens capsule was reported. A vitreous hæmorrhage is treated by rest and absorptive measures.

Burns of the Lids.

Burns of the lids occur in aviators whose machines catch fire. Similar injuries may be inflicted by the use of liquid fire projected on entrenched soldiers and in other military circumstances. The application of tannic acid to the lids causes some contracture and rigidity and thereby the cornea is exposed to drying and ulceration.

A coagulant effect without tissue contracture may be effected by the following procedure. Clean the burn and adjacent skin with normal saline, remove oil and grease with soap, open any blisters and remove loose epidermis. Paint the area with gentian violet 1 per cent. aqueous solution, which is non-irritant, strongly bactericidal, analgesic, but with poor powers of coagulation. Then wait 5 to 10 minutes and apply silver nitrate 10 per cent. This has a coagulating effect without causing contracture. Gentian violet 1 per cent. is re-applied two or three times at 15 minute intervals. The eyes and eyelids are protected by a sterile wire gauze cage covered with a dry gauze dressing. On the second day gentian violet is re-applied once or twice. A dry dressing is applied and removed daily for three or four days, then every four days. When *B. coli* infect the burn gentian violet is replaced with a mixture of gentian violet, acriflavine and brilliant green. The eschar is very pliable, does not crack at the skin folds or at the edges. If it is adherent, as is sometimes the case in third or deep second degree burns, surgical removal by excision under sodium pentothal anæsthesia and Thiersch grafting is indicated. In severe cases tarsorrhaphy may be necessary to save the eye.

The above description is a brief survey of some of the commoner non-perforating injuries that may assail the eyes in modern warfare.

REFERENCES.

- FOSTER, J. (1939) *Brit. Med. J.* **2**, 1181. Private Communications.
LIVINGSTON, P. C., and WALKER, H. M. (1940) *Brit. J. Ophthal.* **24**, 67.
Medical Manual of Chemical Warfare. H.M. Stationery Office, London.
Official History of the War, 1914-18. Surgery. Vol. II.
PHILLIPS, T. (1940). *Proc. Roy. Soc. Med.* Feb.
POOLE, L. T. (1940). *Modern Trends Ophthalmology*. London.
STALLARD, H. B. (1940). *Brit. J. Ophthal.* **24**, 56.
WALLER, A. S., WELLER, C. V., et alia, (1918). *Jl. Lab. Clin. Med.* **4**, 785.
WÜRDEMANN, *Injuries of the Eye*. 2nd Ed. Kimpton.