

# MEDICAL PRACTICE

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## Contemporary Themes

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### Ocular Injuries caused by Airgun Pellets: An Analysis of 105 Cases

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#### Summary

One hundred and five cases of airgun pellet injuries of the eye have been analysed. The average age was 14 and the male to female ratio 7.5:1. Forty-five patients had final visual acuities of 6/18 or less in the injured eye and 19 of these had the eye removed. The two main causes for poor vision were retinal damage and cataract. One patient became completely blind after sympathetic ophthalmitis arising 11 years after the injury. The pellet lodged in the orbit in 14 cases and three of these, together with one who had an intraorbital pellet, were investigated for abnormal lead levels in blood and urine. The results were normal.

The circumstances of the injury were obtained in 12 cases and most involved careless handling of a gun. Instruction of children and parents in schools and on television, rather than stricter legislation, is suggested as a means of prevention.

#### Introduction

The eyes are particularly vulnerable to injury from airgun pellets and direct hits invariably result in severe damage and often loss of the eye. Most reports are largely concerned with small series or single cases.<sup>1-5</sup> Domke,<sup>6</sup> reporting in Polish, did present 58 cases, but to our knowledge no large series has appeared in English. This paper, which was prompted by the

admission of five children in a single week in 1972 with serious airgun pellet injuries of the eye (cases 96-100), analyses 105 cases treated at St. Paul's Eye Hospital, Liverpool, between 1953 and 1972. The report emphasizes the danger of air weapons and suggests possible means of reducing the incidence of injuries.

#### Present Series

Most of our information was obtained from hospital notes of inpatients, though all the patients seen in 1972 and a few of the earlier cases were examined by us personally. The hospital has a high turnover (118,602 outpatients in 1971) and draws on a large proportion of the Merseyside population.

Electro-oculography was done by a technique similar to that of Arden *et al.*<sup>7</sup> Measurements of lead in blood and urine were made by atomic absorption spectrophotometry.<sup>8</sup>

The table describes the cases in chronological order but does not include less important injuries such as conjunctival contusions and eyelid lacerations, haematomas, and abrasions. The commonest injuries were retinal oedema and haemorrhage (49.5% of major injuries), hyphaemia (59%), and vitreous haemorrhage (41%).

#### Visual Prognosis

Sixty patients (57%) had a final vision of 6/12 or better, many having had a small hyphaemia which cleared spontaneously or minor retinal damage which resolved.

The main cause of poor vision in the 25 patients with visual acuities less than 6/12 was retinal damage (12; including four with retinal detachments and one with a macular hole), cataract (7), vitreous haemorrhage (3), choroidal tear (1), and optic nerve damage (1). One case was amblyopic in the affected eye and this was present before the injury.

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## Clinical Data on the 105 Cases

Case No.	Year	Sex and Age	Eye	Hyphaema	Iridodialysis	Cataract	Vitreous Haemorrhage	Retinal Oedema and Haemorrhage	Retinal Detachment	Rupture of Globe	Intraocular Pellet	Intraorbital Pellet	Operation	Final Visual Acuity (Snellen)	Miscellaneous
1	53	M. 14	R.	+	+	+		+	+				Enucleation	6/60	
2	53	M. 18	L.	+	+										
3	54	M. 12	R.	+	+									6/5	
4	54	M. 20	L.	+	+									6/6	
5	54	M. 12	L.										Enucleation	6/9	
6	56	M. 16	L.	+											
7	56	M. 14	R.	+									Wound repair, enucleation	6/6	
8	56	M. 11	L.	+										6/18	
9	56	M. 7	R.	+		+							Cataract surgery (twice)		
10	56	M. 14	R.	+									Wound repair, enucleation		
11	56	M. 15	R.	+		+							Cataract surgery, enucleation		Sympathetic ophthalmitis
12	57	M. 12	R.	+	+									6/24	
13	57	M. 10	R.	+	+									1/60	
14	57	M. 15	L.	+										6/12	
15	57	M. 12	L.	+									A.C.W.O., enucleation		Secondary glaucoma
16	58	M. 13	L.	+										6/9	
17	58	M. 15	L.	+	+	+							Cataract surgery	6/24	
18	58	M. 11	R.	+										6/9	
19	58	M. 16	L.	+										H.M.	
20	58	M. 15	R.			+							Wound repair, enucleation		
21	59	M. 12	L.							+				6/5	
22	59	M. 13	R.											6/9	
23	59	M. 14	R.	+										6/60	
24	59	M. 16	L.	+										6/6	
25	59	M. 16	R.											6/18	
26	59	M. 36	R.						+				Detachment surgery	6/36	
27	59	M. 10	L.	+									A.C.W.O.	6/12	
28	59	M. 17	R.	+		+							A.C.W.O. (five times), enucleation		
29	59	M. 14	L.	+	+									6/6	
30	59	M. 48	R.	+										6/6	
31	59	M. 10	L.	+	+	+							Cataract surgery (twice), A.C.W.O. (twice)	6/12	
32	60	M. 18	R.	+										6/6	
33	60	M. 14	R.	+										6/6	
34	60	M. 11	L.	+										6/12	
35	60	M. 22	L.	+										6/9	
36	60	M. 12	R.											6/9	
37	61	M. 13	R.											6/6	
38	61	M. 20	R.											6/6	
39	61	M. 13	R.	+						+			Wound repair, enucleation		
40	61	M. 12	L.									+	Pellet removed	6/6	
41	61	M. 15	L.							+		+	Wound repair, enucleation		
42	61	M. 12	L.	+										6/6	
43	61	M. 12	L.											6/18	Amblyopia
44	61	F. 13	L.											6/9	
45	61	M. 5	L.									+		6/24	
46	61	M. 13	L.							+			Enucleation		Small scleral laceration
47	61	M. 11	L.											6/9	
48	61	M. 15	R.	+										6/6	
49	62	M. 11	L.	+	+								A.C.W.O.	6/6	
50	62	M. 11	L.	+	+									6/6	
51	62	M. 16	L.	+	+									6/5	
52	62	M. 14	R.			+							Cataract surgery	4/60	
53	62	F. 23	L.	+										6/6	
54	62	M. 16	L.	+	+								Cataract surgery	6/18	
55	62	M. 23	R.	+								+	Pellet removed	6/9	
56	62	M. 14	L.	+	+									6/5	
57	62	M. 10	L.	+										6/6	
58	62	M. 8	L.	+	+								Cataract surgery	2/60	
59	62	F. 14	L.											6/6	
60	62	M. 12	R.	+	+									6/5	
61	62	M. 16	R.	+										6/5	
62	62	M. 13	R.	+								+	Wound repair, evisceration		
63	63	F. 14	R.	+										6/6	
64	63	M. 14	L.	+										6/6	
65	64	M. 19	L.											6/6	
66	64	F. 15	L.											6/6	
67	64	M. 15	R.	+	+									6/9	
68	64	M. 15	L.	+										6/6	
69	64	M. 14	L.											6/5	
70	64	M. 42	R.	+	+									1/60	Macular hole
71	65	M. 12	L.	+										6/6	
72	65	M. 16	L.	+								+		P.L.	
73	65	M. 13	L.	+										H.M.	
74	65	F. 12	R.	+	+	+				+			Wound repair, A.C.W.O.	6/5	
75	65	M. 40	R.							+			A.C.W.O., cataract surgery		
76	65	F. 15	R.										Enucleation	6/6	
77	65	M. 18	L.							+				6/6	
78	65	F. 16	R.	+		+							Enucleation	6/5	
79	66	M. 18	L.	+		+							Cataract surgery (twice)	6/6	
80	66	F. 9/12	R.	+									Cataract surgery, A.C.W.O.		Vision unobtainable, Resolution complete
81	66	M. 6	L.											6/18	
82	66	M. 15	R.											6/6	
83	66	M. 17	R.											6/5	
84	66	M. 12	R.											6/6	
85	67	M. 7	L.	+									Wound repair, enucleation		Infected eye
86	68	F. 4	L.							+				6/6	
87	69	M. 14	R.	+										6/6	
88	69	M. 14	R.											6/6	
89	70	M. 12	R.	+	+	+								6/36	
90	70	F. 12	L.									+	Pellet removed	6/18	
91	70	M. 11	R.											6/36	
92	71	F. 15	R.	+										6/36	Vision not recorded
93	71	M. 15	L.	+									Cryotherapy to retinal hole	6/9	
94	72	M. 15	R.											6/6	
95	72	M. 13	L.											6/6	
96	72	M. 18	R.	+						+			Pellet removed from nasal cavity		
97	72	F. 15	R.	+						+			Wound repair, enucleation		
98	72	M. 13	L.							+			Wound repair, enucleation		
99	72	M. 15	L.	+						+			Detachment surgery	2/60	
100	72	M. 14	R.							+			Wound repair, enucleation		
101	72	M. 11	L.	+										6/36	
102	72	M. 16	L.	+						+			Pellet removed	2/60	
103	72	F. 15	R.										Wound repair, enucleation		
104	72	M. 11	R.	+										N.P.L.	
105	72	M. 14	R.	+										6/9	
														6/6	

Nineteen patients (18%) had their injured eye removed, one by evisceration and the rest by enucleation. In 16 of these the pellet had ruptured the globe. Repair was usually attempted, but in five cases enucleation was the primary procedure because the eye was so severely injured. In only one patient (case 73) did the eye survive a perforation without subsequent enucleation, and then the final vision was hand movements only. In 12 cases the pellet entered and remained in the globe (figs. 1 and 2), and not one of these eyes was saved. One eye (case 85) developed a purulent endophthalmitis before excision. The indications for enucleation in the three cases where the globe was not perforated were sympathetic ophthalmitis (case 11), secondary glaucoma (case 15), and a blind, irritable eye after multiple irrigations of the anterior chamber (case 28).

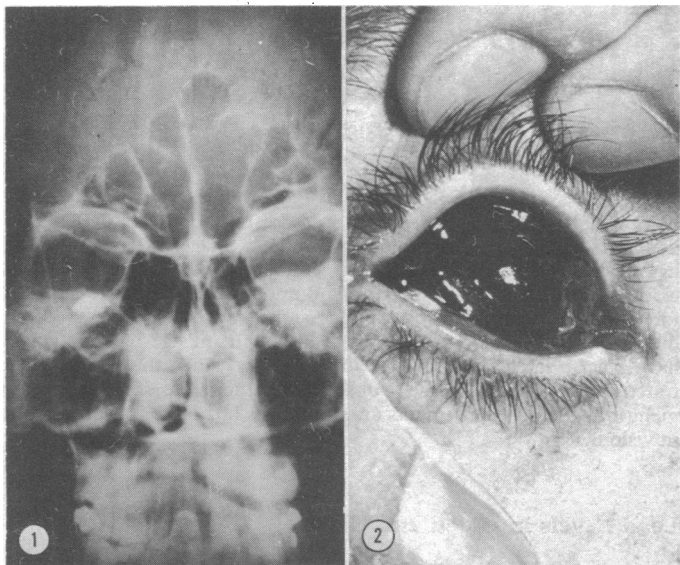


FIG. 1—Case 96. X-ray appearances of intraocular pellet. FIG. 2—Case 96. Grossly disorganized eye after entry of pellet into globe.

### Circumstances of Injury

The circumstances of the injury were obtained in 12 cases. Case 51 (boy aged 16) was hit by a boy aged about 15, who was firing at random at other children in a park. Many others were hit on other parts of the body. Case 53 (woman aged 23) was walking down the road when a pellet fired by an unseen marksman hit her eye. Case 65 (man aged 19) was firing at a wall and a pellet rebounded into his eye. Case 96 (man aged 18) was hit by a rebound off a wire while he was shooting at a bird. Case 74 (girl aged 12) was shot by a 15-year-old boy who was "just playing around with an air pistol." Case 75 (man aged 40) was hit by his son, who was cleaning an airgun. Case 81 (boy aged 6) was accidentally shot by a 17-year-old boy two gardens away; the culprit was fined £10. Case 82 (boy aged 15) was hit by a friend aged 15, who aimed and fired the gun not knowing that it was loaded. Case 88 (boy aged 14) while standing behind a shed was shot by a friend who did not know he was there. Cases 101 (boy aged 11) and 104 (boy aged 11) were both shot accidentally by strangers in the street. Case 103 (girl aged 15) was shot by a younger brother, who was playing with an airgun.

### Traumatic Cataract

Thirteen patients developed concussion cataracts, of which two (cases 1 and 89) were minor and did not require surgery. Of the remaining 11, three (cases 74, 78, and 79) gained visual acuities better than 6/12, but two of these were intolerant of a

contact lens. Four (cases 31, 74, 78, and 79) developed secondary squints. Many of the eyes injured by penetrating wounds had lens damage, but as all except one were enucleated this was not a problem in relation to subsequent management. Seven cases had an iridodialysis in addition to a cataract.

### Retinal Detachment

Cases 1, 19, 26, and 98 developed traumatic retinal detachments, and five of the enucleated eyes were noted to have detachments on histological examination. Case 1 was lost to follow-up with a lower-half detachment which was reducing his visual acuity to 6/60. Case 19 was also lost to follow-up, and when he was last seen he was thought to have a total retinal detachment. The diagnosis was uncertain because of hazy media. Case 26 developed a detachment in association with a retinal dialysis. This was successfully treated with diathermy but the final visual acuity was only 6/36 and he developed a divergent squint. Case 98 had a severe contusional injury of the left globe after a pellet had entered the orbit and lodged near its apex. On admission there was extensive commotio retinae and a vitreous haemorrhage. A few days later diffuse chorioretinal atrophy affected almost the whole of the nasal half of the retina. The temporal half appeared to have been spared, but nearly three weeks after the injury a retinal detachment developed caused by a large dialysis of the lateral side from one to five o'clock. This was treated with cryotherapy, release of subretinal fluid, and scleral indentation with a silastic plomb. The retina flattened but the final visual acuity was only 2/60.

Case 93 developed a retinal hole without detachment, and this was treated with cryotherapy.

### Electro-oculography

Three patients (cases 98, 101, and 104) had electro-oculography. Case 98, who had an extensive left retinal disturbance and a retinal detachment, showed a flat left curve with a normal right response (fig. 3). Case 104 had a small area of retinal oedema and

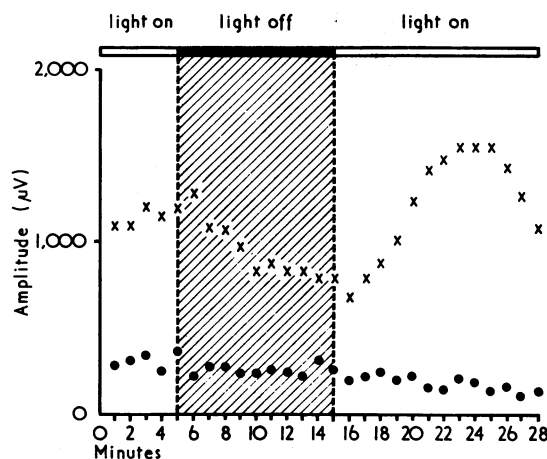


FIG. 3—Case 98. Abnormal left (●) electro-oculogram. Right (X) electro-oculogram normal.

some vitreous opacities in the injured eye, and the electro-oculogram was normal in both eyes. Case 101 had widespread left retinal pigmentary changes as the result of his injury, and a left curve was flat 12 days after the accident. A repeat test 15 days later, when the visual acuity had improved slightly, still showed a flat curve, but the standing potential had risen to the same level as on the unaffected side.

### Sympathetic Ophthalmitis

Case 11 was of unusual interest as an unsuspected ruptured globe eventually resulted in sympathetic ophthalmitis and a tragic outcome.

In February 1956 the patient was hit in the right eye by an airgun pellet and he presented with total hyphaema. When this cleared he was found to have a traumatic cataract, and after further haemorrhage into the anterior chamber a secondary glaucoma developed. In January 1957 a capsulotomy was performed, and by March 1957 the media had cleared sufficiently to give a corrected visual acuity of 6/12. The secondary glaucoma continued, and late in 1957 the intraocular pressure rose to 45 mm Hg. He was treated with topical physostigmine and cortisone, together with acetazolamide tablets. Over the next three years the eye showed no inflammation but the intraocular pressure remained high. The vision gradually failed and was 6/60 in April 1960.

He was not seen again until August 1967, when he presented with a ten-day history of failing vision in his good left eye. Examination showed the right eye to be shrunken and blind and the left vision reduced to counting fingers. There was an active endophthalmitis in both. A diagnosis of sympathetic ophthalmitis was made and the right eye was enucleated. The left eye was treated with systemic, local, subconjunctival and retrobulbar steroids and the visual acuity improved to 6/12, but over the next four months the eye remained active despite continued treatment. By 1972 the vision had fallen to a doubtful perception of light and the lens was cataractous.

Histological examination of the enucleated right eye confirmed the diagnosis of sympathetic ophthalmitis, and in addition a 5 mm gap in the sclera filled with granulation tissue was detected at the equator of the globe (fig. 4).

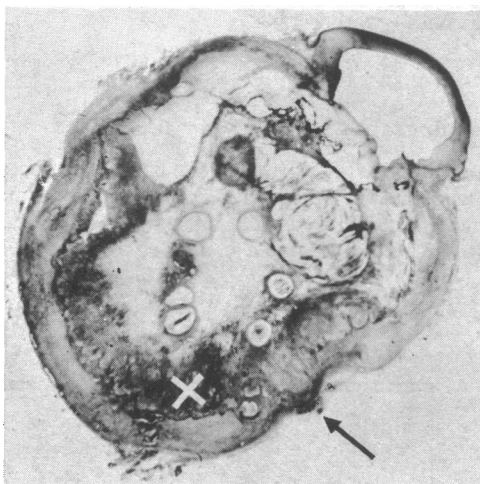


FIG. 4—Case 11. Enucleated right eye 11 years after injury showing scleral rupture (arrowed) and sympathetic inflammatory reaction (marked with cross).

### Intraorbital Pellets

In 14 patients the pellet lodged in the orbit (see table), usually penetrating the eyelid on route. In two further cases the pellet traversed the orbit, reaching the ethmoidal sinus in one (case 99, fig. 5) and the nasal cavity in the other (case 95). The intraethmoidal pellet was retained, while that in the nasal cavity was recovered by an E.N.T. surgeon. Of the 14 intraorbital pellets 5 were removed at operation (cases 40, 41, 55, 90, and 101) and 9 were left in situ, though in three of these patients (cases 4, 45, and 72) extraction was attempted but the pellet could not be located.

In only one patient (case 103) was there any notable damage to the soft tissues apart from the globe and eyelids.

The patient, a 15-year-old girl, was hit by a pellet shot by a younger brother, who was playing with an airgun. The pellet penetrated the right upper eyelid and came to rest at the back of the orbit near the optic foramen (fig. 6). This caused traumatic mydriasis, extensive retinopathy, and vitreous haemorrhage but no penetrating wound

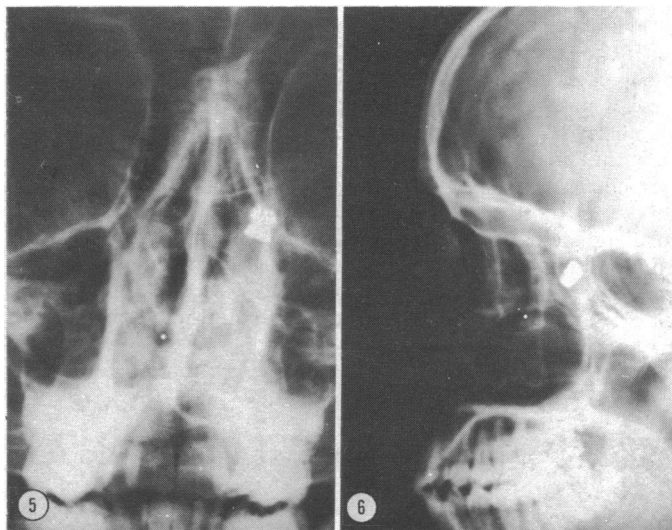


FIG. 5—Case 99. Intraethmoidal pellet. FIG. 6—Case 103. Radiological appearances of intraorbital pellet.

of the globe. Ocular movements were restricted in adduction and depression and a slight ptosis was present. She could not perceive light with the injured eye. The retinopathy, although extensive, would not result in total blindness and optic nerve damage was therefore almost certain. The restricted ocular movement was possibly due to an oculomotor nerve injury, although muscle damage could have been a factor, particularly in the ptosis, since the pellet penetrated the levator palpebrae. Subsequently there was some improvement in the ocular movements and the ptosis but there was no change in vision.

### Lead Levels in Blood and Urine

Three patients (cases 81, 82, and 98) with retained intraorbital pellets and one (case 99) with an intraethmoidal pellet were investigated for abnormal lead levels in blood and urine. In two patients the pellet had been retained for six years and in the other two for only a few weeks. The blood in cases 81, 82, 98, and 99 (two measurements) contained 24, 18, 17, and 34 and 25  $\mu\text{g}$  of lead/100 ml respectively, and the urine in cases 81, 82, and 98 (two 24-hour saves in each case) 54 and 48  $\mu\text{g}$ , 84 and 74  $\mu\text{g}$ , and 41 and 20  $\mu\text{g}/24$  hr. The normal value for blood lead is 3.1–32.7  $\mu\text{g}/100$  ml, and for urinary lead 4–111  $\mu\text{g}/24$  hr.

### Discussion

#### INTRAORBITAL PELLETS AND LEAD IN BLOOD AND URINE

Most metals retained in the orbit, including lead, are inert and in the absence of infection cause no disturbance apart from their bulk,<sup>9</sup> but Leschke<sup>10</sup> and Machle<sup>11</sup> between them described six cases in which lead poisoning was ascribed to retained lead foreign bodies in various parts of the body following gunshot injuries. One patient had a shrapnel pellet in the head of the humerus but did not develop lead poisoning for 10 years; another fell ill four months after the injury. Machle stated that under certain circumstances lead is acted on by the tissues and made available for absorption and x-ray films may show evidence of local dissemination. He concluded that lead poisoning from pellets left in the tissues, although rare, can occur and that the possibility of delayed intoxication should have some weight in the decision on the removal of pellets. Horiuchi<sup>12</sup> did not find typical lead poisoning in six patients with bullets in the tissues, but some showed an increase in lead content in the blood and urine.

To our knowledge no cases of lead poisoning from retained intraorbital lead pellets have been reported, but since these

pellets contain over 99% lead<sup>13</sup> we investigated three patients (cases 81, 82, and 98) with intraorbital pellets and one (case 99) with an intraethmoidal pellet for abnormal lead levels in blood and urine. The results were normal except for one blood level in case 99, which was marginally raised. The repeat test done a few days later, however, gave a normal result and there were no clinical signs of lead poisoning in any of the four cases. Thus although it is safe to leave a pellet in the orbit the remote possibility of lead poisoning occurring years after an injury should not be forgotten.

#### ELECTRO-OCULOGRAPHY

Gliem<sup>14</sup> found that the electro-oculographic response is often impaired by contusional injuries of the eye, and this was confirmed in cases 98 and 101. Both patients had extensive retinal changes in their injured eye, and this was reflected in the flat curve. The rise in the standing potential in case 101 after an interval of 15 days might have indicated some degree of recovery, but since the potential is known to be very variable this observation may not be significant. In case 104 the retinal damage was minor and the electro-oculogram was normal.

Electro-oculography does not provide information of any additional value if the media are clear, as the fundus can be assessed more accurately with the ophthalmoscope. If the fundus view is obscured, however—for example, by hyphaema or cataract—electro-oculography is useful in determining whether the retina has been damaged, and a more accurate prognosis can thereby be established.

#### SYMPATHETIC OPHTHALMITIS

Sympathetic ophthalmitis usually arises within eight weeks of a perforating injury, although it has been recorded as late as 50 years.<sup>15</sup> The 11-year interval in case 11 was not unique, therefore, but most unusual. Removal of the injured eye soon after the injury would have protected the left eye, but when the patient failed to attend for follow-up in 1960 there was no evidence of an intraocular inflammation in the right eye and no reason to suspect sympathetic ophthalmitis. The vision was failing probably as a result of a secondary glaucoma, but this was not an indication for enucleation at the time. Slit-lamp examination of both eyes at regular intervals might have detected early inflammation, and immediate treatment before the ophthalmitis had become well established could have saved some vision. It is understandable, however, that a patient who sees no improvement in his vision over a period of three years despite frequent visits to the hospital and numerous drops should decide that there is little object in continuing to attend the eye clinic.

#### PREVENTION

Two striking facts emerge from an analysis of these results. Firstly, vision is seriously affected (6/18 or less) in 43% of cases, as many as 18% losing the injured eye; and, secondly, the patients' ages fall within a narrow range, the majority being between 10 and 16. This confirms Rawson's finding<sup>5</sup> that the

average case of an airgun injury is a 12-year-old boy. The circumstances of the injuries in the 12 cases where the history was known show that most of the accidents were due to careless handling of a gun, and since the eye is a small target even one ocular injury, assuming that it was accidental and not maliciously intended, must represent an appreciable amount of indiscriminate firing.

The legal aspects of airgun ownership and use are of interest. A licence is not required for an airgun or air pistol, but no person under the age of 17 can purchase or hire one<sup>16</sup> and no person under the age of 14 can accept as a gift or have in his possession an air weapon except when under the supervision of a person over 21 or when he is a member of an approved club or when the weapon is being used at a shooting gallery.<sup>17</sup> Also any person who has any loaded air weapon with him in a public place is liable to imprisonment or a fine.<sup>18</sup>

Since 84% of the injured were under the age of 17 it seems unwise to allow a person of this age to handle an airgun except under the closest possible supervision. Further restrictions could be provided by changing the law. For instance, the age limit for possession of an air weapon could be raised from 14 to 17 and a licence could be imposed, but it is doubtful whether such restrictions would very much alter the availability of airguns to young people or prevent them from handling such weapons in an irresponsible manner. Ricklefs,<sup>19</sup> who analysed 297 general eye injuries in children, recommended the instruction of parents and children, and such an approach in schools and on television may well be of much greater benefit than legal changes. Airguns are all too often handled as though they were toys, and if their dangers are emphasized and their proper handling explained many serious accidents might be prevented.

We should like to thank the consultants of St. Paul's Eye Hospital (Mr. T. D. H. Gray, Mr. S. I. Davidson, Mr. D. M. J. Burns, Mr. A. Patterson, and Mr. R. Mapstone) for allowing us to review patients under their care, and Dr. J. L. S. Smith and Mr. G. L. Turner for preparing the histopathological slide. We are also grateful to Mr. D. C. Cowell for the blood and urine lead estimates, Mr. R. H. McBride for preparing the figures and the table, and Miss E. Grogan and Mrs. M. Kelly for secretarial help.

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