INJURIES FROM FIREWORKS

BY

DOUGLAS JACKSON, M.D., F.R.C.S.

Burns Unit, Birmingham Accident Hospital

Historical

In 1604, the year after James I came to the throne, a plot was hatched to destroy the King and his Government by blowing up the Houses of Parliament. Guy Fawkes, who was the tool of more influential people, was chosen for the dangerous task of setting fire to the gunpowder when Parliament opened on November 5, 1605. But the plot miscarried. Fawkes was arrested as he went to take up his position in the cellars the night before, and the other conspirators were killed or taken prisoner.

Great was the rejoicing at this deliverance. Bonfires were lit and bells rung; and even now, after more than 350 years, the day is still remembered in Britain with bonfires and fireworks.

Few anniversaries can be accompanied by such a trail of injury and suffering throughout the length and breadth of the country. Each year, as this day comes round, explosives are put into the hands of children, who have had little or no instruction or training, so that they may enjoy themselves. The results are what one would expect.

This is no modern development. From the early seventeenth century firework displays were given to mark national celebrations. Commercial pyrotechny, too, was well established. Pepys (1633-1703) describes obtaining "an abundance of serpents and rockets" which his friends flung about, "burning one another and the people over the way" (Brock, 1950).

Richard Wiseman (1705), surgeon to Charles II, also makes detailed reference to a firework injury he treated:

"A young gentleman of about ten years of age, boarded at a School a few miles off, the Evening before the fifth of November having filled his right Pocket full of Squibs and Crackers, threw one of them into the Chymney amongst the Embers. It took fire: but whether it scattered the Fire, and some parts of that flew into his Pocket, or whether it was the Cracker, but those in his Pocket took fire also, and his Cloaths burnt. At the sight whereof his little Chamber-fellow ran out for help. In his absence a little Boy from some other Apartment took the alarm, came in, and seeing his School-fellow in a flame, catch up a Bason of water, and threw it upon him; then ran away for help. Others came in and rescued him out of his burnt Cloaths. A neighbouring Chirurgeon was sent for, who dressed him. The next day they brought the Patient to Town. I found him burnt into the Flesh from a hand's breadth below that Arm pit down that Side, with part of his Belly, and from thence it spread down to the Os ileon and Gluteus, and along the Thigh almost to the knee. And by endeavouring to free his Pockets of the Cracker, he also burnt his Hand from the fingers ends along the side of his Arm to his Elbow-joynt."

After describing his treatment in detail, he concludes:

"Thus I happily cicatrized this young Gentleman's Ulcers even and smooth without the least Inequality, nothing remaining but the red colour to make it discernable."

The Position To-day

For the past 13 years a record of firework injuries on November 5 has been kept at the Birmingham Burns

Unit (Table I). Each year casualties number 30-50; two-thirds are males, and three-quarters are under 15 years. A total of 510 casualties occurred from November 5 celebrations in 13 years. Shocking though this figure appears, it is a gross underestimate of the problem, for firework injuries begin two weeks before the 5th and continue for several days after. For example, on November 5, 1951, rain stopped play: there were 4 casualties on the 3rd, 3 on the 4th, and 21 on the 6th, making a total of 55 over four days. Again, in 1955 there were 15 further casualties on November 6. In Birmingham the ambulance drivers are directed to bring

TABLE I.—*Guy Fawkes Injuries (November 5 Only), 1948-1960*

Year	No. of Casualties	Firework Held in Hand	Face and Eyes	Fireworks in Pocket	Loaded in Clothing or Wellington Boot	Thrown or Kicked	Jumping Firework	Mis-aimed Firework	Opened Firework Gunpowder Lit	Bonfire
1948	31	—	—	—	—	—	—	—	—	—
1949	34	25	5	0 (0)	1 (0)	2	0	1	0	0
1950	60	29	11	4 (4)	0 (0)	0	0	0	0	0
1951	27	18	3	0 (0)	2 (0)	5	0	0	0	3
1952	52	26	2	2 (1)	3 (0)	6	2	3	1	1
1953	40	15	6	4 (3)	4 (0)	0	0	2	0	1
1954	31	15	8	2 (2)	2 (1)	1	2	1	4	3
1955	52	32	6	3 (1)	2 (0)	3	0	2	0	3
1956	37	16	3	6 (5)	0 (0)	3	1	0	0	2
1957	25	5	5	6 (4)	1 (1)	1	2	4	0	4
1958	31	7	2	5 (4)	2 (0)	1	3	3	0	1
1959	38	9	9	9 (6)	4 (1)	3	0	1	0	3
1960	52	9	10	7 (5)	4 (1)	7	1	2	2	7
Total	510	206	70	48 (35)	25 (4)	32	11	19	7	25

Figures in parentheses indicate number operated on.

firework and bonfire injuries to the burns unit, except for eye injuries occurring in isolation, which are taken to the Midland Eye Hospital. It is probable, therefore, that the unit receives about 90% of the firework injuries requiring hospital attention from Birmingham and the surrounding few miles—a population of about 2 million people.

A study of the causes of injury has shown the following trends.

Fireworks Held in the Hand

The commonest cause of injury until 1956 was undoubtedly fireworks held in the hand. Almost half of the injuries were blast effects, occasionally resulting in loss of a finger or phalanx, but more usually splitting the pulp and raising haematomata. The other half were burns, or mixed burn and blast injuries. In 1950, a bad year for this type of case, two patients lost a finger, and one lost part of the index: the youngest victim was a baby of 15 months who received a deep laceration of the hand: he cried and asked to hold a "banger," so his parents let him.

Even when "bangers" are clearly labelled "Not to be held in the hand" it is not surprising that this is overlooked in the environment where these accidents occur—perhaps a dark street with a crowd of boys larking about. Some boys give a history of picking up a "dud" which has failed to go off, and which then explodes in the hand: 15 of the 32 cases in 1955 gave this story—a feature perhaps associated with the very wet day.

In 1957 we were astonished to receive no blast injuries of the hands, and this change has persisted. The reason is clear. Prior to 1957, for some 30 to 40 years, the common "banger" on sale in the United Kingdom was

a penny or twopenny "thunderflash" with a bursting charge of aluminium (or magnesium) and a chlorate. This was a very potent mixture. After the war the sale of fireworks increased greatly, and particularly the thunderflash: this was partly because fireworks had been banned altogether during the war and a generation had grown up which knew nothing of them. In the later months of 1956 the trade agreed voluntarily to discontinue the manufacture of thunderflash fireworks in an effort to reduce noise and to forestall criticism from the public on this ground. They further agreed with the Home Office that in future bangers should contain gunpowder only as a bursting charge, and the quantity should not exceed 40 gr. (2.6 g.). This is a very much tamer article, in regard both to sound and to explosive force (Bennett, 1961). The effect of this policy has been dramatic in the prevention of blast injuries of the hands.

Burn and Blast Injury of the Face

This, the next commonest type of casualty, is usually caused by bending over a firework to light it, though the story given often states that the firework exploded prematurely, or that the child was puffing at the smouldering fuse to make it burn. The eyes are involved in a quarter to half the cases, with burning of the cornea or, less commonly, perforation of the eyeball. May (1956) circularized 70 hospitals with eye out-patient departments in London, and collected 14 major eye injuries due to fireworks on November 5, 1955. Nine people who received flash burns recovered, and one was left with an opaque cornea and vision limited to counting fingers; of the four injuries due to larger fragments of fireworks, two resulted in a blind eye, one in impaired vision, and one in recovery.

FIG. 1

FIG. 2

A boy aged 5 was carrying a pocketful of rockets on November 5, 1956, when they exploded and he received 6% of deep burning (Fig. 1). This healed in two months after primary excision and grafting. A further graft was required in the left groin one year later to correct the contracture. He was finally discharged in April, 1960, with some skin shortage in the perineum but without symptoms (Fig. 2).

FIG. 3

FIG. 4

A boy aged 13 had a pocketful of fireworks on November 5, 1956, which he thought "were set alight by a spark." Six per cent. of deep burning on the thighs, groins, and left hand was excised the same evening and grafted five days later (Fig. 3). The burns were healed in two and a half months after three grafting operations. In the following year he had further grafts to both groins and his penis to correct skin shortage. He was discharged in October, 1958, symptom-free (Fig. 4).

Explosion in Trouser Pocket

The most extensive and deep burns are caused by fireworks exploding in a boy's trouser pocket. Usually this produces a deep burn, about the size of an outstretched hand, which requires excision and grafting and is followed by permanent scarring. Sometimes the clothes are set alight, and the whole leg, or the abdomen, genitalia, and opposite leg, are involved. One such burn in 1959 amounted to 17% of the body surface, and one in 1960 to 13%. It can be seen from Table I that 35 out of 48 burns of this type required skin grafts, most of them by primary excision and immediate grafting—an indication of the depth of these injuries. Two serious cases of this type are illustrated in Figs. 1-4.

Fireworks Lodging in Clothing

A further category is worth mention as being the second commonest cause of deep burns requiring grafting. This is a group in which fireworks lodge in the clothing. Typical histories are "firework fell between neck and coat collar," "firework jumped up leg," or "firework fell into Wellington boot." Of the 25 cases of this kind in this series, nine were due to fireworks falling into Wellington boots, and the four cases requiring skin grafting were all burns from this cause.

Other Causes

The incidence of some injuries due to other causes is also given in Table I. The hazards of throwing and kicking fireworks or letting off jumping squibs in a crowd are obvious: these practices are the result of high spirits and ignorance, or indiscipline. Mis-aimed rockets are not uncommon offenders, and are usually the result of inadequate preparation of a firm stand for firing. Fortunately few boys seem interested in seeing what makes the bang—or they have more sense. Bonfires cause fewer injuries than fireworks, and these are usually due to falling into them, lighting paper, or picking out hot objects.

Severity of Injuries

Table II gives an indication of the severity of the injuries, using 1960 as a sample year. The notes to the table correct any wrong impression which might be gained by using mean figures. The seven "fireworks in pocket" burns averaged 3% in extent, being mostly deep; one grafting operation, a month in hospital, and five out-patient visits for dressings were required before the burns were healed in about two months, with permanent scarring. There were four burns from fireworks in clothes and boots, about the size of the palm and partly deep; one required grafting and in-patient treatment for a fortnight, and the mean healing time for all was seven weeks, involving seven visits to hospital for dressings. The 34 injuries from other causes, excluding eyes, were less severe; on the whole they were small, relatively superficial, and did not require grafting, but the mean healing-time was a fortnight, involving three out-patient visits for dressings. There were seven eye cases associated on average with 1% of surrounding burn: two cases had conjunctivitis only, from superficial burning; two others had corneal abrasions, embedded foreign bodies, and some corneal opacity, but they were healed in 4 and 12 days without permanent disability. Three boys of 5, 12, and 15 years had hyphaemia and corneal abrasions; one was healed

TABLE II.—*Severity of the Injuries (1960)*

	Firework in Pocket	Fireworks in Clothes or Boots	Other Firework Cases— Excluding Eyes	Eye Cases
No. of cases	7	4	34	7
Average area burned*	3%†	4%‡	1%§	1%
„ full-thickness burn*	2%	1%	0%	—
„ No. of operations required	1	0‡	0	0
Average healing-time (days)	61	48	13	19
„ in-patient stay (days)	31	3	0	8
„ No. of out-patient visits	5	7	3	5

Note: Each case is recorded once, according to the principal injury or cause.
* 1% of the body surface is an area the size of the patient's outstretched hand.

† One of these 7 cases was 13% of the body surface.

‡ One of these 4 cases had 1 operation.

§ One of these 34 cases included 1% full-thickness burn.

in 28 days but required capsulectomy six months later for a subluxated opaque lens; the second was left with an opaque white cornea, and the third recovered normal vision.

How Long?

How many more of these anniversaries must come and go, leaving their mark on man, before doctors and the public show serious concern? As those who are responsible for repairing the damage, we see the size of the problem and its futility better than anyone. What steps can be taken to arrest this yearly epidemic of preventable suffering?

Education

One striking conclusion to be drawn from this study is that almost all these accidents arise from the deliberate or accidental misuse of fireworks. For some years now this has been appreciated by the press, which, as November 5 approaches, has co-operated by publishing interest features, with warnings and instructions, such as

Do not hold fireworks in your hand.

Do not put them in your pocket.

Do not bend over them to light them.

This is good advice. Doubtless it has reduced casualties among careful people, and one hopes this prophylactic will continue. But no decline in casualties is noticeable from year to year. Slogans and good advice are not reducing the problem.

Young children have no knowledge of the dangers of fireworks, just as they have no road sense. Labelled instructions cannot be read in the dark, and are often not read in the best light. While fireworks can be obtained by children the task that confronts us is to reach parents who have an antipathy to instruction and to persuade them to train their children in handling explosives. No gift of clairvoyance is required to see that if we depend on education for improvement this problem will still be with us in fifty years.

Restriction

Organized displays, and private parties organized by adults who know the dangers, are a safe form of entertainment. This firm impression is supported by our findings. For example, of the 34 casualties in 1949, 19 were serious enough for follow-up: 18 of these 19 were not in any supervised party; one was with his own parents in the garden.

This raises the possibility of achieving safety by restricting fireworks to organized displays. Restriction would be no novelty, for, as Brock (1950) points out,

"An act of William III made fireworks illegal; the penalty for manufacture or selling was five pounds, and for letting them off, whether on one's own premises or in a public place, was 20 shillings or one month's hard labour": but this legislation failed to control the industry. There is already a restriction on those allowed to buy fireworks—they must not be under 13 years of age; but in practice this regulation is ineffective because it is impossible to enforce in the face of connivance by parents and older boys. The effectiveness of controlling fireworks at the source—that is, at the factory—is clearly shown by the immediate and lasting reduction in blast injuries of the hands since production of the thunderflash was stopped.

The suggestion of legal enforcement does not imply callousness on the part of the trade: the contrary, in fact, is true. From time to time leading manufacturers have agreed among themselves to ban popular types of fireworks which have proved hazardous. For instance, air-bomb types which were produced for some years between the wars have been discontinued; rockets on sale to the general public are limited to the five-shilling size to prevent danger from fall-out of unduly large sticks; and twelve months ago it was decided to discontinue production of aerial torpedo types which fly about in an unpredictable manner (Bennett, 1961).

Substitution

Opposition to change in the field of preventing accidents comes commonly from vested interests, but in this case there is no need to change general custom or spoil sport or restrict production.

Fireworks have been displayed at spas and pleasure gardens under private enterprise since the middle of the eighteenth century: those of C. T. Brock at the Crystal Palace in London from 1865 to 1935 were perhaps the best known. Only a few years ago I attended a crowded privately organized display in a meadow at Tewkesbury, with the Abbey as the scenic backcloth—a perfect, natural setting. This seemed quite to steal the thunder from anything a few boys could put up. It was attended by the public, and, with money raised by the small individual admission fee, sufficient high-quality fireworks were displayed to make a most successful evening—and one which was both safe and, I feel sure, without loss to the manufacturers. With encouragement, local displays of this type could replace the precocious handling of explosives by children. How to develop this substitution profitably is surely a challenge to the trade as a whole.

Conclusion

On the evidence of recent data about firework injuries treated at the Birmingham Accident Hospital, a serious proposition is put forward to reduce the disgraceful and unnecessary suffering of the Guy Fawkes celebration year after year.

This proposition combines legal restriction with an opportunity for the industry to take the initiative in reorganizing the distribution of their products.

Legislation is called for to prohibit the retail distribution of fireworks except for organized displays—nothing less will prevent these injuries.

As a substitute, safe organized displays might well be encouraged for public enjoyment and the welfare of the industry.

I am grateful to my colleague, Mr. J. S. Cason, and to Mr. P. Jameson Evans of the Midland Eye Hospital, for allowing me to use their cases, and to Mr. William Gissane and Dr. John Bull for their interest in this problem which has been a stimulus through the years.

REFERENCES

- Bennett, T. M. (1961). Personal communication.
Brock, A. St. H. (1950). *Chambers's Encyclopaedia*, 11, 391.
May, W. (1956). *Brit. med. J.*, 2, 1039.
Wiseman, R. (1705). *Eight Chirurgical Treatises*, 4th ed., p. 416.
Printed for Benjamin Tooke.

PULMONARY AGENESIS

BY

H. EVERLEY JONES, O.B.E., M.B., F.R.C.P.

AND

C. H. L. HOWELLS, M.D., B.Sc.

The Royal Hospital, Wolverhampton

The congenital absence of a lung or part of a lung is always a surprising finding and is something of a rarity. Burger (1947) collected 54 cases and Wexels (1951) recorded 87. Oyamada *et al.* (1953), in an exhaustive review of the literature, were able to find 73 cases of absent lung and 38 cases of hypoplasia. In 1955 Hochberg and Naclerio reviewed 100 cases and stated that they could find "less than 150 cases reported in the medical journals." Single cases have been reported from time to time in the American literature, notably by Warner *et al.* (1955) and Steiner (1956).

A further case came to necropsy here recently and was accompanied by a number of other defects. The fact that three other examples were treated in one general hospital in the past four years suggests that the condition may not in fact be so rare as has been thought.

Case 1

This patient, the first child of healthy parents, was born normally at home. Regular respirations were established 10 minutes after birth, but breathing was wheezy and a good deal of mucus was produced. A cyanotic attack occurred seven hours later and was terminated by aspiration of the pharynx. He was brought to hospital when 11 hours old. On admission the temperature was 90° F. (32.2° C.) and respiration rate 68 a minute. His colour was normal except for the extremities, which were cold and cyanosed. The right thumb was small and was attached to the hand by a tag of skin. It was noticed that the anus was imperforate and no dimple was seen. An unusually large median raphe extended from the anal region forward along the midline of the scrotum and penis.

Examination of the chest revealed that the left hemithorax was a little fuller than the right. The trachea was deviated to the right and the heart apex beat was behind the sternum. The heart sounds were most clearly heard on the right side of the chest. The percussion note was impaired and the breath sounds were diminished on the right side, while rales were heard, chiefly on the left side. The rest of the physical examination was normal and a catheter was passed into the stomach without difficulty.

X-ray examination of the chest showed the heart to be in the right hemithorax and there was no evidence of a right lung (Fig. 1). X-ray examination of the abdomen with the child inverted demonstrated the presence of air within a short distance of the perineum. Within a few hours a blackening appeared at the perineal end of the raphe. This spread steadily forwards across the scrotum and to the end of the prepuce. It was presumed to be meconium.