Waterslides—are safety standards sliding?

C. J. Gordon & K. L. H. STEVENS

St George's Hospital, London, England

INTRODUCTION

A waterslide is a device constructed of fibre glass or concrete, over which water is continually circulated, of varied direction and inclination, designed to provide a descending ride into a splash-down pool. Popular for some time in America and Australia, it is a relatively new form of leisure pursuit in the United Kingdom. The USA Consumer Product Safety Commission data for 1983 show that waterslides accounted for the largest single share (30%) of amusement park injuries treated in A&E Departments and have been associated with several fatalities. A South Carolina study concluded that 'the uniqueness of waterslide injuries and the lack of injury information . . . indicates that usage rates and rates of injury . . . are yet to be developed', and that study 'might provide some estimate of the role of host factors and environmental factors in avoiding serious or deforming injury'. (Malpass *et al.*, 1981).

In the Spring of 1986 two leisure parks in south west London opened waterslides. During the summer the A&E Department staff at St. George's Hospital, Tooting, received several patients from the two sites and became concerned that safety standards were insufficiently high. A study of the injuries sustained was therefore commenced. The statistics were deduced from the A&E records at St. George's Hospital, Tooting, and Queen Mary's Hospital, Roehampton, St. John's Ambulance records and from the waterslide managements' own data.

RESULTS

At site A the waterslide comprises open and closed sections arranged in a sinuous course extending over 110 feet and ending in a splash pool 3-feet deep. The fall along the length of the slide is 50 feet. It is lubricated by a stream of water and velocities of up to 30 miles per hour may be attained by users who descend feet first sitting or lying down.

Correspondence: Dr K. L. H. Stevens, Consultant, Accident and Emergency Department, St George's Hospital, Blackshaw Road, London SW17 0QT, England.

A guard at the top regulates the frequency of usage and one at the bottom facilitates clearance of the splash pool. About 10,000 people are believed to have used the slide during the 1986 season.

At site B there are four slides arranged side by side, with varying gradients and convolutions, fully enclosed and ending in a 3-feet deep splash pool. Again the slides are lubricated by water. Users descend head first achieving an estimated velocity of up to 40 miles per hour on the steepest slide. The management claim usage of 100 000 rides per annum.

There were in total 57 injuries at site A and 137 at site B.

Analysis was performed by the site and severity of injury (Figs. 1, 2, 3, 4, and Table 1). At site A the injuries were mainly peripheral, principally involving the lower limb and there were few referrals to hospital. Site B showed a vast predominance of head injuries and a large number of those injured required assessment in an A&E Department.

We were able to identify the mechanism of injury in 35 of the cases from site A and 99 of those from site B. Different patterns of injury at the two sites reflect differences in slide design and operation. At site A the majority (17) of the injuries were caused by collision with another person on the slide. Many of these collisions happened when users stopped in the tunnel section in order to wait for their friends and form a 'chain', descending to the pool in a linked group. Nine injuries occurred by contact with the edge of the closed section, and splash pool injuries, either resulting from collision with another user or from injury on the base of the pool, accounted for another nine cases.

Fig. 1 Site of injury from slide at site A.

Fig. 2 Site of injury from slide at site B.

The slides at site B gave rise to the injuries shown in Table 2. Most of the injuries on slide 1 (5 out of 8) and slide 2 (4 out of 5) were caused by collision with the user in front. Those on slides 3 and 4 were related to the design of the chute. On slide 3 there is a 'slalom' section where 8 people lost control and ricocheted from side to side injuring both sides of the head. On slide 4 there is a 45° dip followed by a sharp turn to the right where 68 people received almost identical injuries to the left eye-brow.

The splash pools yielded injuries at both sites but noticeably more at site A. At site A the end of the slide is 18 inches above the splash pool and users fall heavily through the surface of the water leading to injuries to the knees on the bottom of the pool in 5 of our cases. At site B the lip of the slide is level with the splash pool surface. The other splash

Fig. 3 Severity of injuries at site A

Table 1 Type of injury sustained

	Site A		Site B				
	Slide	Splashpool	Slide				Splashpool
			1	2	3	4	
Lacerations	11	2	3	2	14	86	1
Epistaxis	3	—	4	3	1	3	—
Contusion/concussion	17	—	1	—	4	7	—
Broken teeth	2	—	—	—	2	5	—
Dislocation	1	—	—	—	—	1	—
						(shoulder)	
Sprains	13	7	—	—	—	—	—
Haemarthrosis	1	—	—	—	—	—	—

pool injuries were due to collisions, the preponderance of collisions at site A being perhaps due to the underwater jets in the pool at site B which repel users away from the slide ends.

Fig. 4 Severity of injuries at site B. The slides are shown in order of speeds attained and complexity of design slide 1 being the steepest and most sinuous.

Table 2 Injuries sustained on each slide at site B

Slide 1	8
Slide 2	5
Slide 3	21
Slide 4	102
Splash pool	1

DISCUSSION

Studies of injuries sustained at water slides have been undertaken in South Carolina (Malpass *et al.*, 1989), New Zealand (Stokes, 1981), Washington (Washington, 1984; Paulozzi *et al.*, 1986), and Swansea (Davies & Collins, 1986; Moody-Jones, 1986). The studies performed in South Carolina and Swansea were of slides where the user travels head first, that of Washington where the user travels feet first and that in New Zealand was performed on a slide of unspecified usage. Table 3 shows the type of injuries.

In each study the main mechanisms of injury were noted to be interpersonal collision, collision with the side walls of the slide, particularly at sharp turns or dips and contact with sharp or rough surfaces of the slide. The Washington study makes a special note of the risks of sudden drops, particularly for the overweight, and of the dangers associated with tandem riding. The Swansea and Washington studies have led to modifications of user rules.

In August 1986 Blackburn Borough Council closed a 200 feet. waterslide after 'a spate of accidents', one of which involved 5 children who needed hospital treatment. The decision was made to remove a 15 feet. section of the slide after the discovery that an acceleration point just before an S bend, was causing people to 'flip over and injure themselves (Baillieu, 1986).'

Those who use and operate waterslides are subject to the general requirements of the Health & Safety at Work Act, 1984, but the number of incidents occurring at Water Park and Swimming Pool premises led the Health and Safety Executive to call a working party together to look at the safe operation of swimming pools. This working party completed its deliberations in 1986 and is publishing recommendations (Health and Safety Commission, 1988). The report is accompanied by proposals for the standards of supervision in Swimming Pools (Health and Safety Commission, 1988). The recommendations of the working party report contain references to all the design faults which we identified. Unfortunately these publications do not have the force of the law or an accepted code of practice, although the Health & Safety Executive urge meticulous attention to the advice in the booklet on all those concerned with the design, operation and supervision of Swimming Pools and have instructed their Inspectors to take these recommendations into account when considering whether there is compliance with safety regulations.

Both the sites that we studied have been constructed incorporating several design faults giving rise to definable patterns of injury which could be avoided. At site A there were lacerations caused by the tunnel roof at the transition from open to closed sections. These could be prevented by constructing slides that are completely open or entirely closed. At both sites the roofs of the closed sections were opaque, creating blind spots for the life-guards and allowing users to stop and form chains, thereby causing collision injury. Roofs should be clear and life-guard supervision sufficient to put a stop to the practice of 'chaining'. At site B the vast majority of injuries, as experienced by other slides, were caused by contact with the slide walls at two black spots. The design of the slides should be such that undulations and swerves are not so abrupt that they cause users to lose control or be thrown forcibly against the slide wall. There were notably more splash pool injuries at site A than at site B. This suggests that a safe splash pool design has a gentle slope on the last section, that the lip of the slide delivers the rider at

Table 3 Type of injuries noted in other studies

	South Carolina	New Zealand	Washington	Swansea
Spinal fractures	—	—	9	1
Skull fractures	—	—	1	—
Other fractures	—	—	2	5
Unspecified fractures	7%	6 (inc. sprains)	—	—
Concussion	3%	—	13	8
Dental	7%	9	—	—
Bruise-abrasion	25%	6	14	3
Laceration	53%	45	14	17
Sprain	6%	—	7	—
Other	—	3	5	1

pool surface level and that some method of propelling or assisting users rapidly to the end of the pool away from the slide mouth exists.

CONCLUSION

Our results show that a relatively small proportion of those using waterslides are injured. It is our feeling, however, that in an expanding leisure pursuit the situation is unsatisfactory as we identified preventable causes in over 75% of injuries on the slides we studied.

To maintain high standards in accident prevention the recommendations of the Health and Safety Executive must now become a statutory requirement.

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