0022-5282/91/3110-1350$03.00/0
THE JOURNAL OF TRAUMA

Vol. 31, No. 10
Printed in U.S.A.

Injuries in Infants and Small Children Resulting from Witnessed and Corroborated Free Falls

R. A. WILLIAMS, MD

The height of a free fall necessary to cause injury to infants and small children is a confusing and controversial issue among health care, law enforcement, and legal professionals responsible for evaluating cases of possible child abuse. To resolve this confusion, the circumstances of falls were recorded prospectively for 398 consecutive victims of falls seen at Children's Hospital, Oakland, California. From these cases, 106 were selected for further analysis where the falls were witnessed by a second person other than the caretaker and the circumstances of the fall were documented. No injuries occurred in 15 patients, including seven falling more than 10 feet. Mild bruises, abrasions, or simple fractures occurred in 77 patients, including 43 falling more than 10 feet. Severe injuries, including intracranial hemorrhages, cerebral edema, depressed skull fractures, and compound or comminuted fractures occurred in 14 patients falling between 5 and 40 feet. However, no life-threatening injuries occurred in the 3 patients who fell less than 10 feet. These three had small, depressed skull fractures without loss of consciousness, from falling against an edged surface. Only one death occurred in this series, resulting from a fall of 70 feet. In conclusion, infants and small children are relatively resistant to injuries from free falls, and falls of less than 10 feet are unlikely to produce serious or life-threatening injury.

Conflicting opinions have been expressed on the susceptibility of infants and small children to injury from falls. On the one hand, several authors report that severe or even fatal injuries often result from falls from less than 5 feet down to as little as 1 foot.[1-4] On the other hand, Smith et al.[5] and Barlow et al.[6] in studies of free falls from buildings, found that the shortest falls resulting in death were those from the four-story level. Snyder et al.,[7] in a careful study with scene investigation, found that life-threatening injury generally required at least a 15-foot fall, although their series included an unobserved 10-foot fatal fall in a child.

The studies on which these conflicting opinions are based are flawed to varying degrees in that they often depend upon the uncorroborated history of a single caretaker who may be concealing child abuse. The studies of Helfer et al.[8] and Nimityongskul and Anderson,[9] of falls of infants and children in the hospital provide reliable data that indicate that falls of less than 3 to 4 feet do not produce serious injuries, but these studies do not provide information about falls from greater distances.

The discrepancy of opinion regarding the height of a fall necessary to produce serious injury or death in a child creates major difficulties for physicians, child protection services, and law enforcement personnel involved in investigations of possible child abuse where the caretaker describes a fall from a low height. The present study attempts to address the issue of the height of the fall necessary to produce severe injury or death in infants and small children less than 3 years of age by analyzing those cases in which the circumstances of the fall were corroborated by a person other than the primary caretaker. These cases are compared with cases in which the fall was unwitnessed or where there was no corroborating witness.

METHODS

The circumstances were recorded for 398 patients with a history of a fall seen consecutively over a 2-year period at the Children's Hospital—Oakland Emergency Department. Data collected included the patient's age, height, weight, the type of fall (free fall, running fall, fall down stairs, from moving object, etc.), the distance fallen, the surface on which the patient landed, the types of injuries received, Glasgow Coma Scale scores, outcome, and results of Children's Protective Services investigations. The distances fallen and surfaces fallen upon in most cases represent estimates and descriptions by paramedics, caretakers, or witnesses. Witnesses were identified and questioned regarding their observations surrounding each fall.

Cases for inclusion in the study group met the following characteristics: (1) patient age less than 3 years; (2) free unobstructed fall from a stationary object; (3) the fall was witnessed either by two or more people or by a nonrelated person uninvolved in the care of the patient; (4) the height of the fall was

From the Pathology Department, Children's Hospital, Oakland, California.

Address for reprints: Roger A. Williams, MD, Pathology Department, Children's Hospital, 747 52nd St., Oakland, CA 94609.

estimated to the nearest foot (where different observers gave different estimates of height, these estimates were averaged); (5) the injuries and outcome were described.

RESULTS

Three hundred ninety-eight patients seen consecutively in the Children's Hospital Emergency Department with a history of a fall included 106 patients less than 3 years of age where the fall was witnessed and corroborated by an individual other than the caretaker. The details on these patients are presented in Figure 1. Only 3 serious, but not life-threatening injuries occurred in patients falling less than 10 feet. The only death resulted from a 70-foot fall.

In 53 patients under 3 years of age the falls were either not witnessed or were witnessed only by a single caretaker. These patients are compared with the patients whose falls were corroborated in Figure 2 by number, extent of injury, and age group. When cases without a corroborated history are examined, severe injuries occurred in 18 and death in 2 of 53 patients falling less than 5 feet.

DISCUSSION

The data from the study clearly show the resistance of infants and children less than 3 years of age to injury from falls. No life-threatening injuries occurred in falls of less than 10 feet. However, three patients falling between 4 and 5 feet had small depressed skull fractures without loss of consciousness following falls against edged surfaces. These patients were included in the severe injury group. Only mild injuries occurred in 43 patients falling from heights between 10 and 22 feet and no injuries occurred in 7 patients falling between 10 and

1 Bruises, abrasions, cuts or simple fractures
2 Intracranial hematoma, cerebral edema or contusion, depressed skull fracture, ruptured organ or compound or comminuted fracture

FIG. 1. Witnessed and corroborated falls; correlation of height of fall with extent of injury.

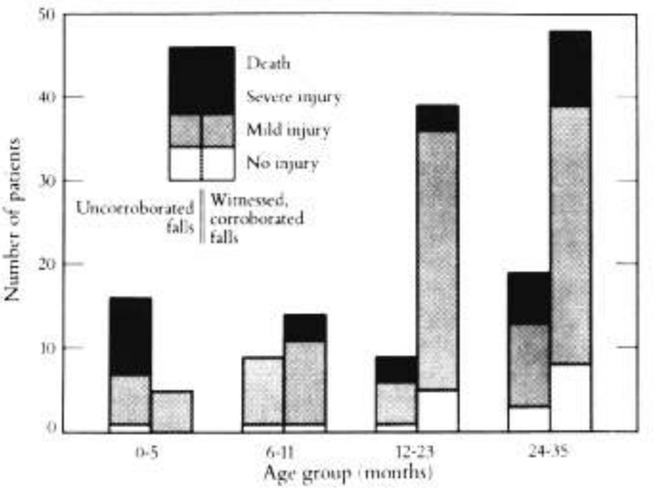

FIG. 2. Comparison of uncorroborated falls with witnessed, corroborated falls by age group and extent of injury.

15 feet. The only death occurred in an infant who fell 70 feet. In general, falls of greater than 6 feet occurred outside from windows, balconies, or porches, accounting for the frequency with which the higher falls were corroborated by independent observers.

Some potential flaws in the data remain. The heights of falls are estimates and do not include on-site measurements. Also, those patients included in the "witnessed by two persons" category often include two members of the same family as the patient, so that cases of child abuse cannot be totally excluded with confidence. Those falls witnessed by two members of the same family, however, were nearly all falls from lower heights, without significant injury. In addition, because only those patients brought to the hospital were studied, the study group is not representative of the population as a whole and is skewed toward including greater numbers of injured patients. However, even when concerns regarding less than optimal data are taken into account, the conclusion remains that infants and small children are unlikely to be seriously or fatally injured in falls of less than 10 feet.

On the other hand, when cases without a corroborated history are examined, severe injuries are common in falls of less than 5 feet and 2 deaths from falls of under 5 feet are included in this group as well. That severe injuries and deaths from falls of 5 feet or less only occurred in the uncorroborated group leads one to suspect that many if not all of these injuries attributed to falls of low height represent child abuse.

REFERENCES

1. Sweeney TB: X-rated playgrounds? *Pediatrics* 64:961, 1979
2. Reichelderfer TE, Overbach A, Greensher J: Unsafe playgrounds. *Pediatrics* 64:962, 1979
3. Aoki N, Masuzawa H: Infantile acute subdural hematoma: Clinical analysis of 26 cases. *J Neurosurg* 61:273, 1984

4. Hall JR, Reyes HM, Horvat M, et al: The mortality of childhood falls. *J Trauma* 29:1273, 1989
5. Smith MD, Burrington JD, Woolf AD: Injuries in children sustained in free falls: An analysis of 66 cases. *J Trauma* 15:987, 1975
6. Barlow B, Niemirska M, Gandhi RP, et al: Ten years of experience with falls from a height in children. *J Pediatr Surg* 18:509, 1983
7. Snyder RG, Foust DR, Bowman BM: Study of impact tolerance through free-fall investigation. Prepared for the Insurance Institute for Highway Safety by the University of Michigan Highway Safety Research Institute. Final Report, 1977
8. Helfer RE, Slovis TL, Black M: Injuries resulting when small children fall out of bed. *Pediatrics* 60:533, 1977
9. Nimityongskul P, Anderson LD: The likelihood of injuries when children fall out of bed. *J Pediatr Orthopedics* 7:184, 1987