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CHILDREN'S OUTERWEAR DRAWSTRINGS AND SLIDING BOARD SAFETY ANALYSIS

By Dennis B. Brickman*



Figure 1 - Subject Jacket

ABSTRACT

A two year old child strangled to death when the drawstrings of her jacket became lodged in a catch point hazard at the top of a residential sliding board. Approaches utilized in the safety analysis include accident reconstruction, safety literature review, standards research, an accident statistics survey, and an evaluation of alternative jacket and sliding board designs. Results of the analysis indicate there are technically and economically feasible design alternatives which prevent the child strangulation hazard associated with the jacket drawstrings and sliding board.

INTRODUCTION

A two year old child was strangled when the drawstrings of her jacket became lodged in a catch point at the top of a backyard slide. The child was last seen alive on the flat surface at the top of the slide and was found not breathing and with no pulse approximately 7 to 9 minutes later laying on the ground a foot in front of the bottom of the sliding board. There were no witnesses to the accident. After the accident, the coroner found a furrow most prominent at the posterior lateral aspect of each side of the child's neck and crossing the entire dorsal surface of the neck. The coroner concluded that the cause of death was accidental drawstring ligature strangulation.

The subject jacket worn by the child at the time of the accident is depicted in Fig. 1. At the top of the neck of the jacket, there are two decorative drawstrings with round toggles at the ends. Each drawstring is approximately 22.9 cm (9 in.) long. The neck drawstrings serve no functional purpose. The jacket was manufactured in 1992. The jacket was purchased by the child's mother at a second hand store on 9/26/98. The accident occurred ten days later on 10/6/98.

The subject residential sliding board involved in the accident is shown in Fig. 2 and Fig. 3. Eight catch points for neck drawstrings have been identified at the top of the subject sliding board. The sliding board was manufactured in 1992 or 1993.

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Figure 2 - Subject Sliding Board

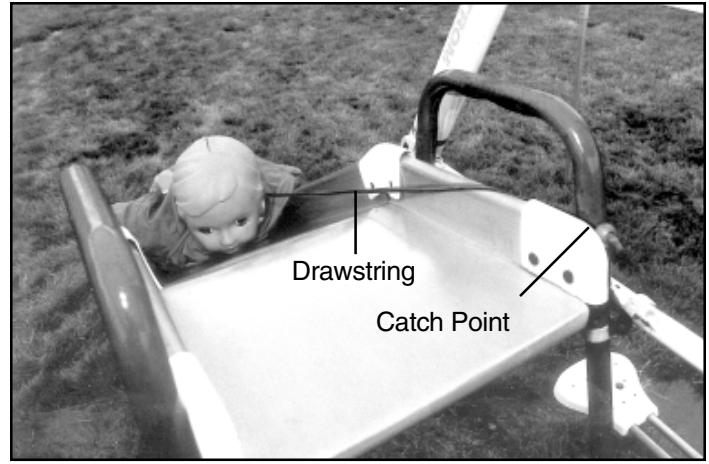


Figure 4 - Drawstring in Catch Point

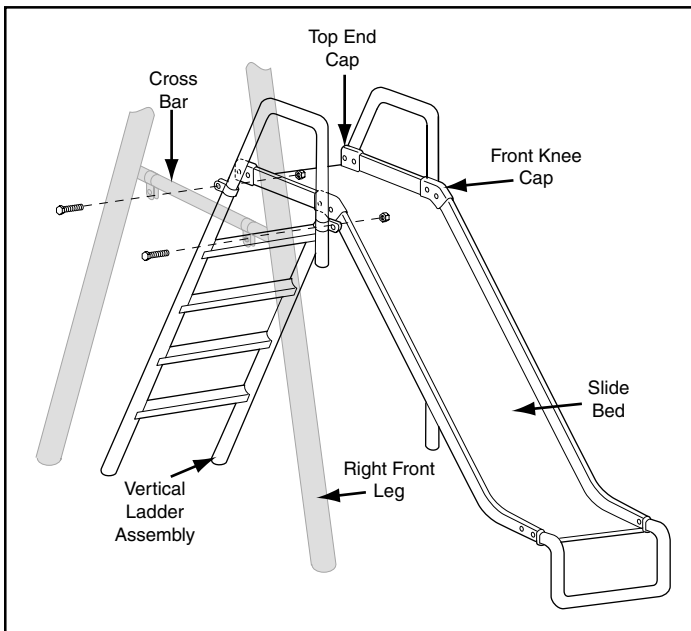


Figure 3 - Subject Sliding Board

ACCIDENT RECONSTRUCTION

An accident reconstruction analysis was conducted using a 14.1 kg (31 lb), 78.7 cm (31 in.) anthropomorphic dummy wearing the subject jacket placed on the subject sliding board. The accident reconstruction was photographed and videotaped. Results of the accident reconstruction are as follows:

1. A single jacket drawstring was placed in the space between the interior of the front kneecap and the interior of the slide bed on both the left and right sides. During all attempts, the drawstring immediately pulled through the kneecap - slide bed interface.
2. A single jacket drawstring was placed in the catch point between the exterior of the right rear top end cap and the interior of the right rear vertical ladder assembly as shown in Fig. 4. The drawstring remained caught for

more than 3 minutes and 57 seconds and then fully released by itself, allowing the anthropomorphic dummy to slide down the sliding board feet first on its front.

3. A jacket single drawstring was placed in the catch point between the right exterior of the horizontal portion of the slide bed and the cross bar. The drawstring remained in this catch point until it was manually released.
4. Both jacket drawstrings were placed in the catch point between the right front leg and the cross bar. After more than 50 seconds, both drawstrings fully self-released from the catch point, allowing the anthropomorphic dummy to slide down the sliding board feet first on its front.
5. During all the trials, the anthropomorphic dummy came to rest on the grass at the front of the slide after it slid down the sliding board feet first on its front.
6. When either a single drawstring or both drawstrings caught in a slide catch point, force was applied to the rear and sides of the anthropomorphic dummy's neck at the drawstring-neck interface. This applied force is consistent with the marks found on the child's neck by the coroner.
7. Potential causes for release of the drawstrings from the slide catch points at the time of the accident include the following:
 - a. Geometry of the drawstring toggles with respect to the catch point.
 - b. Movement of the jacket wearer while the drawstrings are caught.
 - c. Finger aided release of the drawstring from the catch point by another child.
8. Times for full self-release of the drawstring from the slide catch point were achieved which are consistent with the length of time between when the child was last seen on the flat surface at the top of the sliding board and when the child was found laying on the ground in front of the bottom of the sliding board.

9. A tension test was conducted using the waist drawstring from the pants which accompanied the subject jacket. The failure load of this drawstring was 109 pounds, which is more than enough to suspend the anthropomorphic dummy's weight.

DRAWSTRING STRANGULATION HAZARD

Accident Statistics and Safety Literature

For over two decades, the drawstring strangulation hazard has been well documented by accident statistics and in the safety literature. On 5/7/81, the U.S. Consumer Product Safety Commission (CPSC) issued a Special Report on Accidental Strangulations (Ligature) of Children Less than 5 Years of Age [1]. According to this CPSC report, there were 20 strangulation incidents involving hoods or strings on clothing from 1973 through 1980. Furthermore, there were 13 fatal strangulations involving clothing or a rope catching on sliding boards. The CPSC reported that strings on the clothing of infants and toddlers appear subjectively to increase the probability of catching on something when compared to clothing without strings. It appears that a string on a piece of clothing is more likely to get caught on a small projection than is an entire hem of a garment.

In November 1995, the U.S. CPSC issued Guidelines for Drawstrings on Children's Outerwear to help prevent children from strangling or getting entangled by the neck and waist drawstrings of upper outerwear garments such as jackets and sweatshirts [2]. According to these CPSC guidelines, the CPSC received reports of 17 deaths and 42 non-fatal incidents involving the entanglement of children's clothing drawstrings from January 1985 through September 1995. Over two-thirds of the deaths and non-fatal incidents involved hood/neck drawstrings. The majority of these cases involved playground slides. Typically, as the child descended the slide, the toggle or knot on the drawstring got caught in a small space or gap at the top of the slide. Examples of catch points include a protruding bolt or a tiny space between the guardrail and the slide platform. As the child hung by the drawstring, suspended part way down the slide, the drawstring pulled the garment up taut to the neck, strangling the child. Victims in these cases ranged in age from 2 through 8 years old.

Prior to the manufacture of the subject jacket, the jacket manufacturer received notice of an accident involving one of its jackets. According to U.S. CPSC epidemiologic investigation report for case No. 900503CBB1401, in March of 1990, a 3-1/2 year old female had a jacket hood tied on her head with strings with plastic tabs at the ends. The victim was using a slide when one of the tabs caught in a catch on the slide causing the victim to hang on the incline with the string partially around her neck. A notification letter was sent to the jacket manufacturer by the U.S. CPSC for epidemiologic investigation report number 900503CBB1401 on 8/30/90.

Codes and Standards

Following three strangulation deaths of children from drawstrings and after voluntary efforts to eliminate strings were found to be unsuccessful, the United Kingdom issued The Children's Clothing (Hood Cords) Regulations in 1976 [3]. These mandatory regulations prohibited the sale of children's outer garments having a hood designed to be secured by means of a cord drawn through the material. According to a 5/5/94 CPSC memorandum which presents options to address risks to children from clothing string/cord entanglement, no deaths involving hood strings have been reported since the 1976 United Kingdom regulations came into operation [4].

On 1/10/96, a Provisional Safety Specification for Drawstrings on Children's Upper Outerwear was issued by The American Society for Testing and Materials (ASTM) [5]. The performance requirements of this ASTM provisional safety standard state that there shall be no drawstrings in the hood and neck area of children's upper outerwear sizes 2T to 12. This standard, ASTM F1816-97, was approved on 6/10/97 and published in August of 1998 [6].

DESIGN ALTERNATIVES

Warnings

In the fall of 1991, the CPSC released a Consumer Product Safety Alert entitled, Strings Can Strangle Children on Playground Equipment [7]. This safety alert contains a warning and pictograph as shown in Fig. 5. In April 1994, the CPSC Memorandum on Options to Address Clothing String Entanglement Hazards stated that the hazards of clothing strings are not apparent to most consumers [8]. The CPSC



Figure 5 - Consumer Product Safety Warning

concluded that deaths will likely continue unless some action is taken to modify garments to eliminate or reduce the strangulation hazard. After the subject jacket was manufactured, the jacket manufacturer placed warning labels in subsequent jackets regarding the neck drawstring strangulation hazard.

Breakaway Strings

During a meeting between the CPSC staff and manufacturers of children's outerwear with strings on 4/22/94, the issue was raised about using a breakaway string or cord [9]. The CPSC staff stated that since a very small amount of pressure on the neck can slow or stop oxygen getting to the brain, a breakaway cord is probably not feasible. Also, it would break when a child pulled on it to tie it and would probably come apart in the laundry.

Eliminate Drawstrings

On 7/7/94, the CPSC issued a release stating that manufacturers and retailers had agreed to modify or eliminate drawstrings from hoods and necks of children's clothing [10]. On 9/28/95, the CPSC issued a Human Factors Analysis of Drawstrings on Children's Garments memorandum where the human factors staff concluded that strings at the neck of children's outerwear garments are a strangulation hazard and that no safe length of string can be recommended [11]. On 11/16/95, the CPSC took the additional step of issuing voluntary guidelines that advise manufacturers to eliminate drawstrings and to replace them with safer alternatives such as snaps, buttons, velcro and elastic as illustrated in Fig. 6 [12]. According to CPSC documents, these clothing modifications are relatively simple and would reduce the cost of manufacturing [8 - 9]. It should be noted that in 1994, subsequent to the manufacture of the subject jacket, the jacket manufacturer made a jacket with a similar collar and zipper and without a drawstring.

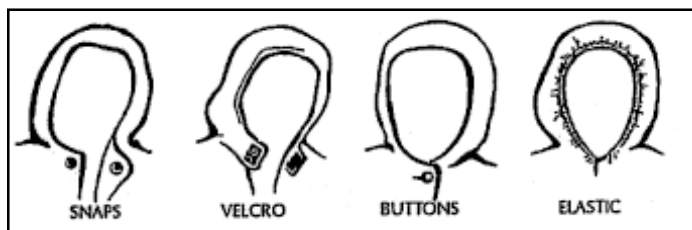


Figure 6 - Drawstring Alternatives

SLIDING BOARD CATCH POINT HAZARD

Accident Statistics and Safety Literature

For over two decades, the sliding board catch point hazard has been well documented by accident statistics and in the safety literature. In March 1975, a CPSC Hazard Analysis of Injuries Relating to Playground Equipment cited

two cases where girls, aged 2 and 4, were strangled when the poncho each was wearing caught on a vertical member of a slide railing [13]. In an August 1979 HIA Hazard Analysis Report on Public Playground Equipment, the CPSC reported that clothing entrapment was an important cause of sliding board related deaths where the clothing or rope caught at the top of the slide and the victim was strangled upon sliding [14].

In April 1990, the CPSC issued a report on Playground Equipment-Related Injuries and Deaths stating that it appeared that clothing was involved in at least 25 cases of strangulation from 1973 through September 1989, most often on slides and swings [15]. Items such as scarves, strings on clothing (mittens, jackets, ponchos, etc.), and hoods of jackets were reported to have been caught on protruding hardware (e.g., bolts), in narrow gaps between equipment components, on vertical posts, and on an open swing support hook.

According to CPSC accident statistics, the manufacturer of the subject slide has a history of strangulation accidents where children's clothing has caught on their sliding boards. These accidents occurred prior to the manufacture of the subject sliding board and/or prior to the subject accident.

1. According to U.S. CPSC IDI # 881024CCC2031, on 4/14/88, a 3 year old female died of asphyxiation when the string from her mittens became entangled on the slide rails of a playground slide. This caused the child's jacket to be pulled up around her neck.
2. According to the U.S. CPSC epidemiologic investigation report for case number 921026HCC1893, on 10/2/92, a string on a hooded sweatshirt worn by a 3 year old female became entangled on the handrail of a backyard sliding board. A notification letter was sent to the sliding board manufacturer by the U.S. CPSC on 3/31/93.
3. According to the U.S. CPSC epidemiologic investigation report for case number 940112CCC3183, on 7/15/93, two children aged 7 and 5-1/2 years became entrapped on separate occasions at the top of a backyard slide when a pull cord on their outer clothing got snagged in a space between two fabricated sheet metal sections.
4. According to the U.S. CPSC epidemiologic investigation report for Case No. 950127CBB1288, on 11/26/94, an 8 year old female was asphyxiated when the barrel clamp on the end of the waistband string of her coat became caught on the top edge of a backyard sliding board. As the victim went down the sliding board, the string became taut pulling the coat and zipper up around her neck. The victim never revived and died 10 days later as a result of brain damage.

Codes and Standards

The home playground equipment industry, as represented by the National Association of Children's Home Playground

Manufacturers, Inc., developed Voluntary Product Standard PS 66-75, Safety Requirements for Home Playground Equipment, under the jurisdiction of the National Bureau of Standards [16]. This standard went into effect in 1976. The hazard of children's clothing or objects around a child's neck catching on a piece of equipment is not explicitly addressed in this safety standard.

A five year review and revision of Voluntary Product Standard PS 66-75 culminated in the publication of ASTM F1148-88, Standard Consumer Safety Performance Specification for Home Playground Equipment, in October 1988 [17]. According to the rationale for ASTM F1148-88, changes were made in order to minimize or eliminate the potential for clothing entanglement and falls from the top of slides. At the time of manufacture of the subject sliding board, the 1991 or 1993 revision of ASTM F1148 was in effect. In February 1992, the chair of the subcommittee of F-15 on consumer products that is responsible for the continued development of ASTM F1148 stated that items such as hoods, ponchos, scarves and mittens with strings connecting them can still become entangled on home playground equipment [18].

In November 1993, ASTM F1487-93, Standard Consumer Safety Performance Specification for Playground Equipment for Public Use, was published [19]. The introduction of ASTM F1487-93 states that the standard addresses fatalities reported to the CPSC resulting from entanglement of clothing or similar items on equipment. According to paragraph 6.3.2 of ASTM F1487-93, slides including protective barriers and their method of attachment and transition areas pose a greater risk of entanglement than other areas of play equipment.

DESIGN ALTERNATIVES

Warnings

According to the operating instructions requirements of Voluntary Product Standard PS 66-75, Safety Requirements for Home Playground Equipment, the operating instructions shall include statements warning the parent to dress children appropriately; examples would include wear well fitting shoes, and avoid ponchos, scarves, and other loose-fitting clothing which is potentially hazardous while using equipment [16]. The operating instructions requirements were adopted by ASTM F1148 (1991 and 1993). The manual for the subject sliding board dated 3/3/93, contained a safe play tip which states, "Apparel such as hats with chin straps, helmet, and loose items around the waist, chest or neck can be hazardous when playing on this equipment." However, subsequently the sliding board manufacturer changed this warning in its manual to explicitly warn of the danger associated with drawstrings getting caught on playground equipment as follows: "TEACH YOUR CHILDREN THEY MUST: NOT wear loose clothing, clothing with hoods or drawstrings, jewelry, ponchos, scarves or untied shoelaces or other loose-fitting clothing which is potentially hazardous while using equipment." According to the Safety Hierarchy [20], warnings represent the third priority in safety design.

Slide Guard

On 8/6/92, the CPSC issued a news release stating that the subject slide manufacturer was providing consumers with guards to prevent entanglement of strings on children's clothing in the handrail attachment area of certain slides. This news release refers to the report received by the slide manufacturer that a three year old girl strangled when her mitten strings, which were strung through her coat, caught at the point where the handrail attaches to the slide. The plastic guard offered by the slide manufacturer fills in the handrail to slide area where a child's clothing may catch and result in strangulation. It should be noted that applying safeguarding technology is considered to be the second priority in the Safety Hierarchy.

Eliminate Catch Point Hazard

According to the Safety Hierarchy, the first priority is to eliminate the danger through design by eliminating the hazard and/or the risk. In accordance with this first priority, the sliding board manufacturer has developed a design which eliminates several of the catch point hazards associated with the subject sliding board. Figure 7 depicts a sliding board with this alternative design which is located in the backyard immediately adjacent to the subject backyard.



Figure 7 - Alternative Sliding Board Design

CONCLUSIONS

An accident reconstruction analysis utilizing the subject jacket, the subject sliding board, and an anthropomorphic dummy indicates that a strangulation hazard exists when the jacket drawstrings get caught in one of the sliding board catch points. Subsequently, the drawstrings fully release from the slide catch point and the anthropomorphic dummy comes to rest on the ground at the front of the sliding board after sliding down feet first on its front. The primary goal of this investigation is to make designers and users more aware of the drawstring-sliding board catch point strangula-

tion hazard and to identify design alternatives to help reduce the number of these types of injuries. The Safety Hierarchy would suggest that attempting to eliminate the drawstring-sliding board catch point strangulation danger through design is the first priority. Applying safeguarding technology and warning of the danger are the second and third priorities respectively. Design alternatives such as snaps, buttons, velcro, and elastic for the subject jacket drawstrings and designs which eliminate catch points for the subject sliding board fall into the first priority of the Safety Hierarchy by eliminating the danger. These technically and economically feasible design alternatives which are available in the marketplace would prevent children from strangling due to drawstrings catching on sliding boards.

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