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Pediatrics 2008;122:1244-1251

DOI: 10.1542/peds.2007-3551

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://www.pediatrics.org/cgi/content/full/122/6/1244>

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American Academy of Pediatrics

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Unintentional Child Poisonings Treated in United States Hospital Emergency Departments: National Estimates of Incident Cases, Population-Based Poisoning Rates, and Product Involvement

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The authors have indicated they have no financial relationships relevant to this article to disclose.

What's Known on This Subject

Despite a substantial reduction in fatal child poisonings involving drugs and other hazardous household substances in recent years, nonfatal child poisonings treated in hospital EDs have remained at high levels.

What This Study Adds

This study develops national estimates of poisonings involving children <5 years of age treated in US hospital EDs, evaluates the characteristics of the children involved, and quantifies the products involved, including products subject to child-resistant packaging requirements.

ABSTRACT

OBJECTIVES. The goals were to develop national estimates of unintentional child poisoning cases treated in US hospital emergency departments, to determine population-based poisoning rates, and to evaluate characteristics of the victims and the products involved.

METHODS. Cases reported through the US Consumer Product Safety Commission National Electronic Injury Surveillance System, involving a national probability sample of US hospital emergency departments, were used as a basis for developing national estimates of product-related poisonings involving children <5 years of age treated in US hospital emergency departments in 2004.

RESULTS. There were an estimated 86 194 child poisoning incidents treated in US hospital emergency departments in 2004, amounting to 429.4 poisonings per 100 000 children. Approximately 70% of the poisonings involved children 1 or 2 years of age, slightly more than one half involved boys, and 13.3% resulted in hospital admission. Approximately 59.5% of the poisonings involved oral prescription drugs, oral nonprescription drugs, or supplements. Other major product categories resulting in poisonings included cleaning products (13.2%), drugs and ointment preparations intended for external use (4.9%), and personal care products (4.7%). Approximately 54.7% of the poisonings involved products already subject to child-resistant packaging requirements under the Poison Prevention Packaging Act.

CONCLUSIONS. Despite advances in recent years, unintentional child poisonings remain an important public health concern. The circumstances surrounding poisonings need to be evaluated further, and intervention strategies need to be developed. *Pediatrics* 2008;122:1244–1251

FATAL CHILD POISONINGS involving drugs and other hazardous household substances have decreased substantially in recent decades. According to data from the National Center for Health Statistics, fatal poisonings involving children <5 years of age have decreased from >200 per year in the early 1970s to an average of <35 per year in recent years.¹

Despite the dramatic decrease in fatal child poisonings, unintentional nonfatal poisonings involving children remain an important public health concern. On the basis of calls to US poison control centers, each year >1 million children <5 years of age experience potentially toxic ingestions.^{2,3} Moreover, according to estimates from the US Consumer Product Safety Commission (CPSC) National Electronic Injury Surveillance System (NEISS), US hospital emergency departments (EDs) have treated >80 000 unintentional poisonings involving children <5 years of age every year since 2000.

Although unintentional medication poisonings involving children have been described,⁴ there has been little systematic analysis of the full range of products involved in child poisonings treated in hospital EDs, poisonings

www.pediatrics.org/cgi/doi/10.1542/peds.2007-3551

doi:10.1542/peds.2007-3551

The views expressed in this article are those of the authors. The article has not been reviewed or approved by and may not necessarily reflect the views of the US Consumer Product Safety Commission.

Key Words

product-related poisonings, children, poisoning rates, emergency department

Abbreviations

CPSC—Consumer Product Safety Commission

ED—emergency department

CI—confidence interval

PPPA—Poison Prevention Packaging Act

NEISS—National Electronic Injury Surveillance System

CR—child-resistant

Accepted for publication Mar 4, 2008

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PEDIATRICS (ISSN Numbers: Print, 0031-4005;

Online, 1098-4275); published in the public

domain by the American Academy of

Pediatrics

involving products already subject to child-resistant (CR) packaging requirements under the Poison Prevention Packaging Act (PPPA), or the relative severity of the different types of product-related poisonings. The major purposes of this study were to develop national estimates of unintentional child poisoning cases treated in US hospital EDs, to characterize population-based poisoning rates, and to evaluate the characteristics of victims and the types of products involved.

Information on the distribution and severity of poisonings in children <5 years of age is particularly important to the CPSC, which administers the PPPA.⁵ The PPPA grants the CPSC the authority to require that certain hazardous household substances be sold in special CR packaging if the CPSC determines that CR packaging "is required to protect children from serious personal injury or serious illness resulting from handling, using, or ingesting such substance." As defined in the Federal Hazardous Substances Act,⁶ the term "hazardous substances" means, among other things, substances that are toxic or corrosive. Since the enactment of the PPPA, the CPSC has issued >20 regulations requiring CR packaging for specific substances or classes of substances.⁷

METHODS

Data in this study were for poisonings treated in 2004 and reported through hospitals participating in the CPSC NEISS. The NEISS involves a stratified, national, probability sample of hospital EDs that allows CPSC staff members to make national estimates of product-related injuries. The sample consists of ~100 of the ~5400 US hospitals that have ≥ 6 beds and provide 24-hour emergency service. The sample contains 5 strata, including 4 based on hospital size (ie, the total number of ED visits reported by the hospital); the fifth stratum consists of children's hospitals. Hospitals within each stratum are ordered according to state and zip code and are selected systematically to ensure wide geographic coverage.^{8,9}

Each participating NEISS hospital provides information on all injuries (including poisonings) involving consumer products that are treated in the hospital ED. This information includes the age and gender of the victim, the final injury diagnosis of record, the body part injured, a description of as many as 2 products that were involved in the injury, and the disposition of the case. Each record also includes a 142-character narrative field, giving the circumstances surrounding the injury and the product involved.

For purposes of this analysis, poisonings were defined to include ingestions and inhalations of potentially toxic substances and chemical burns resulting from contact with acids, alkalis, or caustic agents. Therefore, we selected all NEISS cases coded as poisonings or chemical burns that involved children <5 years of age from January 1, 2004, through December 31, 2004. NEISS cases were coded as poisonings when the victim (1) swallowed a liquid or soluble chemical or drug, (2) inhaled vapors, fumes, or gases, with the exception of carbon monoxide vapors and smoke from fires (which are coded as anoxia), or (3) swallowed a liquid or soluble chemical or drug and had an allergic reaction. Product-related chem-

ical burns, which are also covered by the PPPA, were included because contact with consumer products containing acids, alkalis, or caustic agents can cause serious personal injury or illness, including systemic toxicity within the body in some cases. Poisonings or allergic reactions resulting from insect bites or living plants, shrubs, or trees were excluded from the analysis,¹⁰ as were unintentional poisonings related to medical procedures or parenteral drugs administered by health care professionals, because they did not involve product-related poisonings under the control of consumers.

The poisoning cases were categorized according to the type of product involved, based on information provided in the narrative field. When the product (or ingredient) involved was regulated under the PPPA, the product category was based on the PPPA regulation that covered the product (eg, oral prescription drugs or hydrocarbons). For cases involving unregulated products, the categories were based on the end use of the products. If >1 product was involved, then the product (or ingredient) considered the most toxic or the most likely to be responsible for the ED visit was used to categorize the poisoning case. In addition, some of the cases involved oral nonprescription medications that contained multiple ingredients regulated under the PPPA. In those cases, the product was categorized according to the ingredient most identified with the product or brand. For example, if a product was generally identified as a nonprescription acetaminophen product, then acetaminophen would be selected as the product category even if the product also contained diphenhydramine (a regulated antihistamine).

Because the NEISS involves a national probability sample of hospitals, each of the poisoning cases was assigned a sample weight based on the adjusted inverse of the known probability of selection of the hospitals in each stratum. The inverse of the probability of selection is simply the total number of hospitals in the sampling frame divided by the number of hospitals at each stratum level. Adjustments to these weights are made for nonresponse, hospital mergers, and changes in the sampling frame. The weights were summed to provide national estimates of product-related nonfatal child poisonings in the United States. Variance estimates were based on a direct variance estimation procedure that took into account the complex sample design.^{8,9} National estimates of ED visits and corresponding 95% confidence intervals (CIs) were calculated by using the Surveymeans procedure in SAS 9.1 (SAS Institute, Cary, NC). When national injury estimates from the NEISS are based on small sample counts, they are subject to considerable variation. The CPSC considers national estimates to be potentially unreliable when (1) the estimate is <1200, (2) the number of records used is <20, or (3) the coefficient of variation exceeds 33%.¹¹ The coefficient of variation, which represents a measure of the sampling variation, is estimated as the SD of the estimate divided by the estimate. Population-based poisoning rates were estimated by using midyear, age-specific, population estimates for 2004, based on information from the US Census Bureau.^{12,13}

RESULTS

Overall Findings

In 2004, a total of 3145 product-related poisoning cases involving children <5 years of age were reported through the NEISS. These cases represented an estimated 86 194 child poisonings (95% CI: 70 720–101 668 poisonings) treated in US hospital EDs, or ~429.4 ED-treated injuries per 100 000 children <5 years of age (95% CI: 352.–506.5 injuries per 100 000).

There were 78 NEISS cases (representing 1790 ED-treated poisonings throughout the nation, or 2.0% of the total) involving >1 product that required a judgment regarding the product most likely to be responsible for the reported symptoms. Another 25 cases (representing 561 ED-treated poisonings, or <1% of the total) involved medications that might have contained >1 regulated ingredient, which were categorized on the basis of the ingredient most identified with the product or brand (usually acetaminophen, aspirin, or diphenhydramine). In addition, 48 cases (representing an estimated 1932 poisonings, or 2.2% of the cases) were determined to be out of scope, including 42 cases related to medical procedures or parenteral drugs administered by health care professionals and 6 cases involving reactions to insect stings or the ingestion of living plants. All of the poisonings were nonfatal. Although there were 22 unintentional child poisoning deaths in 2004,¹ none was reported from the NEISS sample of EDs. This is not surprising, given that NEISS hospital EDs account for <2% of hospital EDs throughout the nation.

Demographic and Injury Characteristics

Table 1 provides information on child poisonings for selected characteristics. Children 1 and 2 years of age accounted for almost 70% of the poisonings. The highest estimated poisoning rate involved children 1 year of age, with an estimated 800.2 ED-treated injuries per 100 000. Although this estimated poisoning rate was somewhat higher than the rate for 2-year-old children, it was ~2.7 times (95% CI: 2.0–3.4 times) the rate for children 3 years of age, 3.6 times (95% CI: 2.4–4.8 times) the rate for children <1 year of age, and 6.5 times (95% CI: 4.4–8.6 times) the rate for children 4 years of age. Boys accounted for slightly more than one half (54.6%) of the poisonings.

Approximately 13.3% of the poisonings resulted in hospitalization, as opposed to the patient being treated and released. Approximately 27% of the hospitalized victims were reported to have been admitted for observation. Approximately 4.2% of poisonings were diagnosed as chemical burns. The setting locale was coded as unknown in almost one fourth of the cases. Among cases in which the setting was known, however, ~98% were described as occurring in a home setting.

Product Involvement

Tables 2 and 3 provide information on the distribution of poisonings and poisoning rates according to product category and whether the products were regulated under the PPPA and therefore were subject to CR packaging

TABLE 1 Estimates of Nonfatal Poisonings and Poisoning Rates for Children <5 Years of Age Treated in US Hospital EDs, According to Selected Characteristics

Characteristics	No. of Poisonings (%)	Poisoning Rate, Estimate (95% CI), Cases per 100 000 Age-Specific Population
Total	86 194 (100.0)	429.4 (352.3–506.5)
Age		
<1 y	9066 (10.5)	222.4 (164.3–280.4)
1 y	32 309 (37.5)	800.2 (644.2–956.2)
2 y	27 901 (32.4)	697.8 (565.2–830.5)
3 y	12 101 (14.0)	298.7 (247.1–350.4)
4 y	4817 (5.6)	123.3 (92.2–154.4)
Gender		
Male	47 053 (54.6)	458.5 (373.2–543.7)
Female	39 065 (45.3)	398.3 (325.3–471.3)
Unknown	76 (0.1)	
Disposition		
Treated and released	74 757 (86.7)	372.5 (306.1–438.9)
Hospitalized	11 437 (13.3)	57.0 (42.4–71.5)
NEISS diagnosis		
Poisoning	82 608 (95.8)	411.6 (336.7–486.5)
Chemical burn	3586 (4.2)	17.9 (13.0–22.8)
Setting where injury occurred ^a		
Home	65 287 (75.7)	
Public space	1273 (1.5)	
Unknown	19 634 (22.8)	

^a Rates are not presented because of a substantial proportion of unknown data.

requirements. Not all products subject to the packaging regulations are sold in CR packaging; medications prescribed by physicians may be dispensed in non-CR packages when directed by the physician or requested by the purchaser. For other substances, manufacturers may supply packaging of a single product size that does not comply with the regulations, if it is labeled and the manufacturer also supplies the substance in packages that do comply with the regulations.⁵

Of the estimated 86 194 product-related poisonings in 2004, an estimated 47 112 (95% CI: 36 585–57 639 poisonings) involved products regulated under the PPPA, and an estimated 35 635 (95% CI: 29 216–42 054 poisonings) involved unregulated products. An estimated 3447 poisonings (4.0%) involved products that could not be identified sufficiently to determine the regulatory status. Approximately 17.8% (95% CI: 15.1%–20.3%) of the poisonings involving regulated products resulted in hospitalization. In contrast, ~6.6% (95% CI: 4.7%–8.5%) of the poisonings involving unregulated products resulted in hospitalization.

Of the poisonings associated with the regulated product categories, an estimated 43 733 (95% CI: 33 808–53 658 poisonings) involved oral drug preparations, accounting for ~217.9 poisoning injuries per 100 000 children <5 years of age. Regulated oral drug preparations include oral prescription drugs and commonly used nonprescription pain relievers, such as acetaminophen, ibuprofen, aspirin, and naproxen sodium.

Low-viscosity hydrocarbon products and solvents were associated with an estimated 1988 ED-treated child

TABLE 2 Estimates of Nonfatal Poisonings for Children <5 Years of Age Treated in US Hospital EDs, According to Product Involvement and Injury Disposition

Product Category	No. of Poisonings, Estimate (95% CI)	Proportion of Poisonings, %	No. Treated and Released, Estimate (95% CI)	No. Hospitalized, Estimate (95% CI)
Regulated products				
Oral drug preparations	43 733 (33 808–53 658)	50.7	36 176 (27 542–44 810)	7557 (5573–9541)
Low-viscosity hydrocarbons	1988 (1263–2713)	2.3	1529 (945–2113)	460
Other	1391 (828–1954)	1.6	1009	382
Total	47 112 (36 585–57 639)	54.7	38 714 (29 576–47 852)	8398 (6295–10 501)
Unregulated products				
Cleaning products	11 386 (8648–14 124)	13.2	10 803 (8184–13 422)	583
Oral nonprescription drugs/supplements	7568 (5612–9524)	8.8	6960 (5004–8916)	608
Preparations for external use	4201 (3123–5279)	4.9	3868 (2982–4754)	333
Personal care products	4048 (3013–5083)	4.7	3933 (2916–4950)	116
Other	8432 (6543–10 321)	9.8	7706 (5944–9468)	725
Total	35 635 (29 216–42 054)	41.3	33 270 (27 378–39 162)	2365 (1367–3363)
Unknown	3447 (2265–4629)	4.0	2773 (1740–3806)	674
Total	86 194 (70 720–101 668)	100.0	74 757 (61 435–88 079)	11 437 (8515–14 359)

Totals may not sum because of rounding. NEISS estimates based on small sample sizes should be used with caution, particularly those based on a sample size of <20 or yielding estimates of <1200, because the sampling variability for such estimates is large in comparison with the estimates themselves. Consequently, CIs for such estimates are not provided.

TABLE 3 Estimates of Nonfatal Poisoning Rates for Children <5 Years of Age Treated in US Hospital EDs, According to Product Category

Product Category	Poisoning Rate, Estimate (95% CI), Cases per 100 000 Age-Specific Population
Regulated products	
Oral drug preparations	217.9 (168.4–267.4)
Low-viscosity hydrocarbons	9.9 (6.3–13.5)
Other	6.9 (4.1–9.7)
Total	234.7 (182.3–287.2)
Unregulated products	
Cleaning products	56.7 (43.1–70.4)
Oral nonprescription drugs/supplements	37.7 (28.0–47.5)
Preparations for external use	20.9 (15.6–26.3)
Personal care products	20.2 (15.0–25.3)
Other	42.0 (32.6–51.4)
Total	177.6 (145.6–209.5)
Unknown	17.2 (11.3–23.1)
Total	429.5 (352.4–506.6)

poisonings (95% CI: 1263–2713 poisonings). The applicable PPPA regulations define “low-viscosity” products as those measuring <100 Saybolt Universal Seconds when tested at 100°F. These products include kindling and illuminating preparations (eg, lighter fluid and lantern fuel), infant oil, paint solvents, and some furniture polishes.

Other products or substances regulated under the PPPA that resulted in child poisonings included sodium and potassium hydroxides (eg, drain openers and oven cleaners), methanol (eg, windshield washer fluid), ethylene glycol (eg, automobile antifreeze), mouthwashes containing ethanol, lidocaine and dibucaine preparations, products with >0.5% elemental fluoride (as occasionally used in some cleaning products), and turpentine. Together, these products were involved in an estimated 1391 poisonings (95% CI: 828–1954 poisonings).

Regarding unregulated product categories, an estimated 11 386 poisonings (95% CI: 8648–14 124 poisonings) involved cleaning products. Common household liquid bleach was the cleaning product most frequently reported for child ingestions, accounting for approximately two fifths of the cleaning product-related poisonings. Other products included laundry products, automatic dishwasher detergents, and other general household cleaning products.

An estimated 7568 poisonings (95% CI: 5612–9524 poisonings) were associated with oral nonprescription drug and supplement preparations not regulated under the PPPA. Another 4201 poisonings (95% CI: 3123–5279 poisonings) involved drugs, ointments, and other preparations intended for external use. These products included, among others, external analgesic ointments or patches, antiseptics, wart and callous removers, eye drops, and nasal sprays.

Products that can be described as “personal care products,” such as perfumes, soaps, and hair and nail care products, were involved in an estimated 4048 poisonings (95% CI: 3013–5083 poisonings). Another 8432 poisonings (95% CI: 6543–10 321 poisonings) were distributed over >20 other categories of products, such as pesticides, desiccants, and automobile and marine chemicals.

Table 4 presents additional detail on the products involved in the poisonings. Some of the national estimates cannot be considered reliable because of small sample counts. However, the estimates in the last column in Table 4 provide a measure of the relative importance of individual product categories within the national estimate of product-related child poisonings.

DISCUSSION

On the basis of this analysis, there were ~86 194 product-related poisoning injuries (95% CI: 70 720–101 668 injuries) treated in US hospital EDs in 2004, amounting to almost 430 injuries per 100 000 children. Approximately 13.3% of the poisonings resulted in hospitalization; this was >4 times the 3.2% hospitalization rate for

TABLE 4 Estimates of Nonfatal Poisoning Rates for Children <5 Years of Age Treated in US Hospital EDs, According to Product Involvement

	No. of NEISS Cases	National Estimate, No. of Cases	Coefficient of Variation	Proportion of National Estimate, %
Regulated products				
Oral drug preparations				
Oral prescription drugs	1059	30 782	0.127	35.7
Acetaminophen	247	5778	0.148	6.7
Ibuprofen	95	2125	0.187	2.5
Diphenhydramine	64	1841	0.195	2.1
Iron-containing drugs or supplements	46	1092 ^a	0.197	1.3
Aspirin	41	958 ^a	0.272	1.1
Exempted oral prescription drugs ^b	22	781 ^a	0.331	0.9
Other regulated oral drugs	13	376 ^a	0.337	0.4
Low-viscosity hydrocarbons	78	1988	0.186	2.3
Other	44	1391	0.206	1.6
Unregulated products				
Cleaning products				
Household cleaners	185	4793	0.147	5.6
Household bleach	165	4422	0.147	5.1
Laundry products, excluding bleach	32	957 ^a	0.305	1.1
Other	43	1214	0.244	1.4
Oral nonprescription drugs/supplements				
Cough, cold, flu, or allergy medications	108	3393	0.145	3.9
Supplements	42	1391	0.219	1.6
Gastrointestinal remedies	27	1061 ^a	0.259	1.2
Diet aids	23	916 ^a	0.303	1.1
Other	22	807 ^a	0.389	0.9
Preparations for external use				
Dermal drugs and ointments	125	3460	0.136	4.0
Prescription medicines for external use	19	330 ^a	0.374	0.4
Other	11	411 ^a	0.387	0.5
Personal care products				
Nail products (polish or polish remover)	43	1409	0.218	1.6
Hair care products (dyes, relaxers, or depilatories)	41	674 ^a	0.254	0.8
Perfumes and colognes	23	734 ^a	0.357	0.9
Soaps and shampoos	21	399 ^a	0.324	0.5
Other	26	832 ^a	0.270	1.0
Other unregulated products				
Pesticides ^c	43	649 ^a	0.300	0.8
Desiccants	34	884 ^a	0.238	1.0
Gasoline or kerosene	27	859 ^a	0.268	1.0
Automobile or marine chemicals	23	578 ^a	0.354	0.7
Tobacco products	23	601 ^a	0.385	0.7
Room deodorizers	20	505 ^a	0.273	0.6
Other	169	4356	0.148	5.1
Unknown products	141	3447	0.174	4.0
Total	3145	86 194	0.091	100.0

^a National estimates are potentially unreliable when (1) the number of records used is <20, (2) the coefficient of variation exceeds 33%, or (3) the estimate is <1200.

^b Oral prescription drugs exempted from CR packaging requirements include hormone-based birth control pills in mnemonic packaging, hormone replacement therapy products, sublingual forms of nitroglycerin, and sublingual or chewable isosorbide dinitrate in doses of ≤10 mg.

^c CR packaging requirements for pesticides are regulated by the Environmental Protection Agency. Only 1 of the pesticide ingestions involved a product for which the Environmental Protection Agency required CR packaging.

all NEISS-reported injuries involving children <5 years of age in 2004. In addition, ~70% of the children were 1 or 2 years of age and slightly more than one half (54.6%) were boys, findings that are generally consistent with the results of previous studies, including some conducted outside the United States.^{4,14–18}

Approximately 59.5% of the poisonings (51 301 poisonings; 95% CI: 40 233–62 369 poisonings) involved

the ingestion of prescription or nonprescription oral medications (ie, the categories of regulated oral drug preparations and unregulated oral nonprescription drugs and supplements in Table 2). Oral prescription drugs alone accounted for ~30 782 child poisonings (95% CI: 23 124–38 440 poisonings), or ~35.7% of all child poisonings. Products already regulated under the PPPA, and therefore subject to requirements for CR packaging,

were involved in more than one half (54.7%; 95% CI: 52.2%–57.2%) of the poisonings. Although this finding may seem surprising, explanations may involve greater risk exposure associated with the regulated products (ie, the relative availability of the products in the children's environment), the greater toxicity of the regulated products, and the fact that a large proportion of the regulated products include oral drug preparations that young children may, in an attempt to imitate adult behavior, ingest as food objects.¹⁹ With respect to toxicity, poison control centers are more likely to advise parents to seek medical attention after the ingestion of the more-toxic regulated products, compared with the generally less-toxic unregulated products.²⁰

In addition, several factors are known to limit the effectiveness of CR packaging regulations, including the following. (1) CR packaging is not childproof; the testing protocol requires only that 80% of children <5 years of age be unable to open CR packages.²¹ (2) The PPPA does not require that all products subject to the packaging regulations to be sold in CR packaging.⁵ (3) A substantial proportion of child poisonings involve products dispensed in CR packages that were defeated or left insecure at the time of ingestion.^{22,23} (4) CR packaging does not prevent dosing errors.²⁴

Poisonings involving the regulated product categories also tended to be the more-serious injuries; 17.8% of the regulated product poisonings resulted in hospitalization, compared with ~6.6% of the nonregulated product poisonings. Therefore, the hospitalization rate associated with the regulated products was ~2.7 times (95% CI: 1.8–3.6 times) the hospitalization rate for unregulated products. The higher rate of hospitalization for regulated product poisonings is not unexpected, because the products regulated under the PPPA are considered to be the most toxic and life-threatening.

The large number of injuries described in this article, in conjunction with the relatively high rate of hospitalization, suggests that product-related child poisonings remain an important public health concern and that additional poison prevention strategies are needed. Despite the limitations of CR packaging regulations described above, the use of CR packaging has been shown to reduce fatal and nonfatal poisoning rates by ~40%.^{25–27} Therefore, applying packaging regulations to additional toxic household substances constitutes a potentially effective option for addressing some poisoning hazards. The CPSC has also tried to improve the effectiveness of CR packaging. In the middle 1990s, the CPSC revised the testing protocol for CR packaging, in an effort to encourage the development of packaging designs that were easier for older adults to use without compromising the CR characteristics of the packaging.²¹ The testing protocol includes both a child test, to make sure that ≥80% of the children tested are unable to open the CR packaging, and an adult test, to make sure that adults can properly use the packages. The changes in testing requirements affected only the adult panel. Before the revisions, a panel of adults between the ages of 18 and 45 years was used to test the ability of adults to open and to reseal the CR packages. The protocol revisions re-

placed the 18- to 45-year-old panel with a panel of older adults, 50 to 70 years of age. The goal was to reduce child poisonings further by encouraging more consumers, especially older consumers, to use CR packaging and to use it correctly. Since that time, some innovative new packaging designs have been developed,²⁸ and additional improvements in packaging design should be encouraged.^{29,30} To date, however, we are not aware of any study that has attempted to evaluate the impact of the protocol revisions.

Information-based strategies, such as community-wide programs, clinic- and office-based counseling,^{31,32} and others, also are needed to reduce unintentional child poisonings. Many of these types of information-based strategies have been described elsewhere,³³ and health care providers are in a position to play an important role in communicating them.^{34,35} The regional poison control centers in the United States play a particularly important role in this regard.^{36,37} In addition to being available to help the public manage the treatment of possible poisonings after they occur and helping parents avoid costly and time-consuming visits to EDs and doctors' offices,³⁸ poison control centers represent a valuable resource for providing public and professional information about the identification of toxic compounds, acceptable exposure levels, and the safe storage and use of poisonous substances used in and around the home.³³

The findings in this study are subject to several limitations. As a surveillance system for US hospital EDs, NEISS does not provide information on child poisonings treated in other settings, such as physicians' offices, clinics, and ambulatory surgery centers. On the basis of CPSC estimates, poisonings treated outside hospital EDs may account for >50% of all medically attended child poisonings.³⁹ In addition, given the relatively small number of child poisoning deaths annually, the relatively small proportion of hospital EDs that report through NEISS (<2% of the hospital EDs throughout the nation), and the fact that some deaths are unlikely to present at the ED, this study does not provide information on child poisonings resulting in death.

The results are subject to the possibility of coding errors at the NEISS hospitals. Hospital audits conducted by CPSC staff members indicated that hospital coders identify >90% of all reportable, product-related, injury cases.⁴⁰ In addition, this analysis required a judgment regarding the primary poisoning agent in ~3% of the cases in which >1 poisoning agent was mentioned.

Finally, the results of this analysis are not sufficient to provide a detailed characterization of hazard patterns or injury scenarios. We have insufficient information to determine how children accessed the poisoning substance, whether the substance had been transferred from its original container, whether products subject to CR packaging requirements were actually in CR containers at the time of poisoning, or whether dosing errors were to blame.

CONCLUSIONS

Despite advances in recent years and the decrease in unintentional fatal poisonings,⁴¹ unintentional child poisonings remain an important public health concern. The circumstances surrounding poisonings need to be evaluated further and intervention strategies developed. Additional improvements to the design of CR packaging should be promoted, and the public should be encouraged to use CR packaging and to use it properly. Information-based strategies, such as community programs, clinic- or office-based counseling, and others, continue to be needed, and regional poison control centers, which represent a valuable source of information for the public and health care professionals, should be supported. In addition, parents and caregivers should always be encouraged to keep toxic substances out of the reach of children, even when they are already in CR packaging.^{42,43}

ACKNOWLEDGMENTS

We thank John Boja, PhD, for critical review of the manuscript and many helpful comments and Michael Greene, PhD, for assistance with the statistical computations.

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Unintentional Child Poisonings Treated in United States Hospital Emergency Departments: National Estimates of Incident Cases, Population-Based Poisoning Rates, and Product Involvement

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Pediatrics 2008;122;1244-1251

DOI: 10.1542/peds.2007-3551

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