PEDIATRICS

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(doi: 10.1542/peds.2014-0057)

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KEY WORDS

detergent pod, ingestion, NPDS, poisoning, poison control center

ABBREVIATIONS

AAPCC—American Association of Poison Control Centers
NPDS—National Poison Data System
PCC—Poison Control Center

Mrs Valdez conducted the data analysis, and drafted and revised the manuscript; Dr Casavant contributed to conceptualization of the study, assisted in data access and analysis, and critically reviewed the manuscript; Drs Spiller and Xiang contributed to conceptualization of the study, assisted in data analysis, and critically reviewed the manuscript; Mr Chounthirath assisted in data analysis, and revised the manuscript; Dr Smith contributed to conceptualization of the study, assisted in data analysis, and critically reviewed and revised the manuscript; and all authors approved the final manuscript.

www.pediatrics.org/cgi/doi/10.1542/peds.2014-0057

doi:10.1542/peds.2014-0057

Accepted for publication Sep 5, 2014

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

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

FUNDING: Mrs Valdez received a research stipend from the National Student Injury Research Training Program at Nationwide Children's Hospital, funded by the Centers for Disease Control and Prevention (grant 1R49CE002106) and a research stipend from the Child Injury Prevention Alliance while she worked on this study. The interpretations and conclusions in this article do not necessarily represent those of the funding organizations.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

WHAT'S KNOWN ON THIS SUBJECT: Case studies, abstracts, and small-sample research studies have shown that laundry detergent pods pose important poisoning risks to young children.

WHAT THIS STUDY ADDS: From 2012 through 2013, 17 230 children exposed to laundry detergent pods were reported to US poison control centers. Among children exposed, 4.4% were hospitalized and 7.5% experienced a moderate or major medical outcome, including 1 confirmed death.

abstract

FREE

OBJECTIVE: Laundry detergent pods are a new product in the US marketplace. This study investigates the epidemiologic characteristics and outcomes of laundry detergent pod exposures among young children in the United States.

METHODS: Using data from the National Poison Data System, exposures to laundry detergent pods among children younger than 6 years of age during 2012–2013 were investigated.

RESULTS: There were 17 230 children younger than 6 years exposed to laundry detergent pods in 2012–2013. From March 2012 to April 2013, the monthly number of exposures increased by 645.3%, followed by a 25.1% decrease from April to December 2013. Children younger than 3 years accounted for 73.5% of cases. The major route of exposure was ingestion, accounting for 79.7% of cases. Among exposed children, 4.4% were hospitalized and 7.5% experienced a moderate or major medical outcome. A spectrum of clinical effects from minor to serious was seen with ingestion and ocular exposures. There were 102 patients (0.6%) exposed to a detergent pod via ingestion, aspiration, or a combination of routes, including ingestion, who required tracheal intubation. There was 1 confirmed death.

CONCLUSIONS: Laundry detergent pods pose a serious poisoning risk to young children. This nationwide study underscores the need for increased efforts to prevent exposure of young children to these products, which may include improvements in product packaging and labeling, development of a voluntary product safety standard, and public education. Product constituent reformulation is another potential strategy to mitigate the severity of clinical effects of laundry detergent pod exposure. *Pediatrics* 2014;134:1–9

In early 2012, a new form of laundry detergent emerged in the consumer market in the United States. Advertised as a clever replacement for the liquid form, detergent "pods" are small, single-use packets of concentrated detergent encased in a water-soluble membrane.[1,2] The colorful, candylike designs of the products may have contributed to a recent phenomenon involving young children gaining access to the detergent pods and ingesting them or bursting them open, exposing their skin or eyes to the detergent chemicals.[2,3] Exposure has resulted in hospitalization and mechanical ventilation for several days.[1,4,5] Serious medical consequences have been documented, including respiratory distress, marked lethargy and depression of consciousness, and damage to oropharyngeal mucosa.[1,4–6]

Literature on laundry detergent pod exposure in the United States consists largely of case series, abstracts, small-sample data reports from a single state, or national data that span only a brief time period.[1,2,4,5,7,8] Case reports have elucidated some of the most serious clinical consequences after detergent pod ingestion.[1,4,5] A study using Texas Poison Center Network data found that more patients were referred to a health care facility and experienced moderate or major effects after exposure to detergent pods than traditional detergent.[2] Countries in Europe have had laundry detergent pods available since 2001. Studies from the United Kingdom have characterized the most common routes of pod exposure among children, the severity of these exposures, and clinical features seen with each route of exposure.[6,9,10] Detrimental ocular effects, including conjunctivitis, keratitis, and corneal epithelial burns, after ocular exposures to detergent pods have been well-documented in European literature and recently in Canadian case studies.[6,11,12] In Italy, laundry detergent pods have become the most commonly ingested household product since becoming available in 2010.[13]

Using a national database, this study investigates the epidemiologic characteristics of laundry detergent pod exposures and consequences among US children after these products entered the US consumer market in 2012.

METHODS

Data Sources

This study analyzed data from the National Poison Data System (NPDS). The American Association of Poison Control Centers (AAPCC) receives poison call data from each of the participating poison control centers (PCCs) that serve the United States and its territories and maintains the NPDS to catalog each call in near real-time. PCCs offer free, confidential medical advice and poison information through the Poison Help Line 24 hours per day. For each exposure call, PCCs document the product(s) involved in the exposure, the amount reportedly involved, the route of exposure, basic demographic data of the exposed individual, subsequent medical information related to the exposure, and other information regarding the incident.[14] Quality control measures are in place to ensure accuracy and completeness of the data collected. US Census Bureau data were used to calculate population-based rates for laundry detergent pod exposures in this study.[15]

Case Selection Criteria

NPDS data for all laundry detergent pod exposure calls from 2012 through 2013 among children younger than 6 years were requested from the AAPCC. These calls were identified using (1) AAPCC's product codes for specific brands of laundry detergent pods or a general product code for laundry detergent pods, and (2) AAPCC's generic substance codes for "unit dose" laundry detergent for calls with a missing product code. There were 17 287 calls involving at least 1 laundry detergent pod. The following were excluded from the study: 5 calls with an incomplete list of substances involved in the exposure, 51 calls involving a laundry detergent pod and 1 or more non-laundry substances, and 1 "confirmed nonexposure" call. There were 16 623 single laundry detergent pod exposure calls and 607 2-substance exposure calls that had codes for a laundry detergent pod and another form of laundry detergent. E-mail correspondence with the AAPCC indicated that these 2-substance exposure calls were actually a single laundry detergent pod exposure that had been coded with an extra code. Therefore, these calls were included in the study by using the code of the first-ranked substance. This yielded 17 230 calls for this study, including 2 deaths of children 7 and 16 months of age. The autopsy report for the 7-month-old and an unofficial incomplete version of the AAPCC death abstract for the 16-month-old were obtained and reviewed.

Variables

Exposure route was grouped into ingestion, aspiration (with ingestion), dermal, ocular, inhalation, multiple routes with ingestion (including ingestion combined with aspiration, inhalation, ocular, or dermal) and other multiple routes (including combinations of ocular, dermal, inhalation, and other). For subanalysis, exposure routes were grouped into oral (including single or multiple routes with ingestion and aspiration) and nonoral (including dermal, ocular, inhalation, and other multiple routes).

Exposure site was grouped into residence (includes patient's own or other residence) or other (includes health care facility, public area, school, workplace, other, or unknown). The following medical outcome categories are defined by the NPDS: minor effect ("minimally bothersome, rapidly resolving effects that usually involve the skin or

mucous membranes"); moderate effect ("more pronounced or more systemic in nature, treatment usually required but effects non-life-threatening"); and major effect ("symptoms are life-threatening or resulted in significant disability").[16]

When PCCs first began receiving calls about laundry detergent pod exposures, not all of the possible clinical effects associated with this new type of exposure were known. Therefore, some related clinical effects may have been initially coded as "not related" or "unknown if related." For this reason, all clinical effects coded as "related," "not related," or "unknown if related" to the exposure were included in analyses in this study.

Other variables analyzed in this study included patient's age, patient's gender, month of exposure, management site, scenario associated with the child's access to the laundry detergent pod, level of health care received, reason for exposure, and therapy performed. The categories for each of the variables are as defined by the NPDS.[16]

Statistical Analysis and Ethical Considerations

Data were analyzed by using SAS 9.3 (SAS Institute Inc., Cary, NC) software, and descriptive statistics were reported. This study was approved by the Institutional Review Board of The Research Institute at Nationwide Children's Hospital.

RESULTS

General Characteristics

From 2012 through 2013, the NPDS received 17 230 calls (6267 in 2012, and 10 963 in 2013) related to laundry detergent pod exposures among children younger than 6 years. The most common reason for exposure was "unintentional-general," which accounted for 99.6% of cases. The population-based rate for laundry detergent pod exposures was 3.67 per 10 000 US children younger than age 6 years (2.59 in 2012 and 4.57 in 2013). The monthly number of laundry detergent pod exposures increased by 645.3% from March 2012 (137 cases) through April 2013 (1021 cases), and then decreased by 25.1% from April to December 2013 (767 cases); this decrease was almost entirely due to a 24.4% drop from August (1012 cases) to December (767 cases) (Fig 1). There was also a transient 12.5% decrease in the number of exposures from October through December 2012.

Exposure was highest among 1- and 2-year-olds, representing 33.3% and 31.5% of cases, respectively (Table 1). Boys accounted for 51.8% of all cases. The most common route of exposure was ingestion (79.7%), followed by multiple routes with ingestion (10.4%) and ocular (7.2%). Most cases (98.9%) occurred at a residence. Approximately half (53.5%) of cases were managed "on site" (not at a health care facility, usually at the caller's residence) (Table 2).

The scenario associated with the child's access to the laundry detergent pod(s) was recorded for 904 (5.2%) cases. Among these cases, the laundry detergent pods were stored within sight of the child or always left out in 42.3% (382 cases), the pod container was in use and temporarily left open while the caregiver was momentarily distracted in 10.7% (97 cases), stored inappropriately in 9.1% (82 cases), or stored in a low unlocked kitchen or bathroom cabinet in 6.0% (54 cases).

Level of Health Care Received

Among all children exposed to laundry detergent pods, 35.4% were treated and released from a health care facility, 2.4% were admitted to a non–critical care unit, and 2.0% were admitted to a critical care unit (Table 2). Almost all (755 of 769 cases) of those admitted to the hospital were exposed through the oral route (672 ingestions, 51 multiple routes with ingestion, and 32 aspirations). Among children seen at a health care facility for a laundry detergent pod exposure, patients younger than 3 years had a higher proportion of hospitalization than older children (9.9% vs 5.9%). Among patients seen at a health care facility, 12.6% of those exposed through the oral route were admitted to the hospital compared with 1.6% of those exposed through other routes.

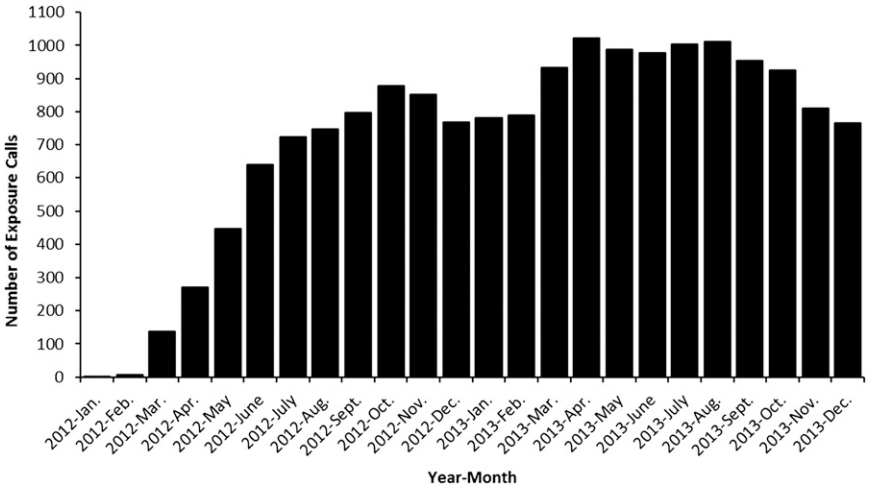

FIGURE 1
Number of laundry detergent pod exposure calls among children younger than 6 years by year and month, NPDS 2012–2013.

TABLE 1 Characteristics of Laundry Detergent Pod Exposures Among Children Younger Than 6 Years, NPDS 2012–2013

Characteristics	No. of Exposure Calls	%[a]
Child age, y		
<1	1515	8.8
1	5729	33.3
2	5425	31.5
3	2739	15.9
4	1263	7.3
5	519	3.0
<6[b]	40	0.2
Gender		
Male	8927	51.8
Female	8269	48.0
Unknown	34	0.2
Exposure site		
Residence (own or other)	17 043	98.9
Other	157	0.9
Unknown	30	0.2
Route of exposure		
Single route	15 157	88.0
Ingestion	13 730	79.7
Ocular	1238	7.2
Dermal	125	0.7
Aspiration	59	0.3
Inhalation	2	0.0
Multiple routes with ingestion	1788	10.4
Ingestion+Dermal	976	5.7
Ingestion+Ocular	434	2.5
Ingestion+Ocular+Dermal	332	1.9
Ingestion+Inhalation	21	0.1
Ingestion+Ocular+Inhalation+Dermal	12	0.1
Ingestion+Ocular+Inhalation	6	0.0
Ingestion+Aspiration+Dermal	3	0.0
Ingestion+Inhalation+Dermal	3	0.0
Ingestion+Ocular+Aspiration	1	0.0
Other multiple routes	286	1.7
Ocular+Dermal	275	1.6
Ocular+Inhalation+Dermal	6	0.0
Ocular+Inhalation	3	0.0
Dermal+Other	1	0.0
Inhalation+Dermal	1	0.0
Unknown	2	0.0
Total	17 230	

[a] Percentages may not sum to 100.0% due to rounding error.

[b] PCCs were unable to obtain the exact age for these cases, but it was known that the child was ≤5 years of age.

Clinical Effects and Medical Outcome

The predominant clinical effects seen with laundry detergent pod exposures among all exposure routes were vomiting (48.0%), followed by coughing/choking (13.3%), ocular irritation or pain (10.9%), drowsiness or lethargy (7.0%), and red eye or conjunctivitis (6.7%) (Table 3). Among children exposed through the ingestion route, the leading clinical effects reported were vomiting (56.0%), coughing or choking (14.6%), drowsiness or lethargy (7.8%), and nausea (4.9%). Other important clinical effects seen in a small number of oral route cases included coma (30 patients), seizures (12), hematemesis (11), pulmonary edema (6), bradycardia (5), respiratory arrest (4), and gastric burns (2). Among the 1238 children with ocular exposures, 50.6% experienced symptoms of red eye or conjunctivitis, 11.7% had corneal abrasions, and 2.7% experienced ocular burns.

A moderate or major clinical effect occurred in 7.5% of children exposed to laundry detergent pods and a minor effect occurred in 50.3% of patients (Table 2). Two deaths occurred in 2013 to 7-month-old and 16-month-old male children. An autopsy confirmed the death of the 7-month-old was due to the laundry detergent pod exposure. The autopsy of the 16-month-old revealed intracranial bleeding, which was not linked to any reported trauma, and the cause of death of this child remains unconfirmed at the time of our review.

Therapies

The most commonly used therapy for all routes of laundry detergent pod exposure was dilution/irrigation/wash, performed in 75.1% of the cases (Table 4). Cases of ingestion and cases of multiple route with ingestion exposure required the most therapies. Tracheal intubation with ventilation was required for 102 patients, including 82 patients who were exposed through ingestion, 10 patients with aspiration, and 10 patients who experienced a multiple-route exposure that included ingestion. Other therapies used among patients with laundry detergent pod exposure included bronchodilators, intravenous fluids, and oxygen (Table 4).

DISCUSSION

Despite existing prevention efforts, the category of household cleaning products is still the third leading substance category associated with poison exposures among children younger than 6 years in the United States.[14] The current study focuses on laundry detergent pods because they were recently introduced into the US consumer market. Although innovative products, such as this one, can make everyday chores quicker and easier, unintended consequences sometimes occur. From 2012 through 2013, US PCCs received >17 000 calls reporting laundry detergent pod

TABLE 2 Management Site, Medical Outcome, and Level of Health Care Received for Laundry Detergent Pod Exposures Among Children Younger Than 6 Years, NPDS 2012–2013

Characteristics	No. of Cases	%[a]
Management site		
Managed on site (non-HCF)	9221	53.5
Patient already in or en route to HCF when PCC called	4756	27.6
Patient was referred by PCC to an HCF	3028	17.6
Other	129	0.8
Unknown	96	0.6
Medical outcome		
Minor effect	8660	50.3
Not followed, minimal clinical effects possible (no more than minor effect possible)	3086	17.9
No effect	3034	17.6
Moderate effect	1189	6.9
Unable to follow, judged as a potentially toxic exposure	780	4.5
Not followed, judged as nontoxic exposure (clinical effects not expected)	268	1.6
Unrelated effect, the exposure was probably not responsible for the effect(s)	111	0.6
Major effect	100	0.6
Death	2	0.0
Level of health care received		
No HCF treatment received	9446	54.8
Treated/evaluated and released	6106	35.4
Patient refused referral/did not arrive at HCF	642	3.7
Admitted to critical care unit	420	2.4
Admitted to non–critical care unit	349	2.0
Patient lost to follow-up/left against medical advice	266	1.5
Admitted to psychiatric facility	1	0.0
Total	17 230	

HCF, health care facility.

[a] Percentages may not sum to 100.0% due to rounding error.

exposures among children younger than 6 years. From March 2012 to April 2013, the monthly number of laundry detergent pod exposures increased by more than 600%. This rapid increase in the number of exposures, in part, reflects the increasing presence of laundry detergent pods in the home environment associated with the increasing popularity and use of these products. In addition, the generic and specific codes for laundry detergent pods were not available to at least some, if not all, of the US PCCs until several months after the PCCs began receiving calls about these products, in which case laundry detergent pod exposures were assigned other generic and specific product codes. Such incorrect coding also might have occurred for some laundry detergent pod exposures after the codes were available. Therefore, the increased use of the generic and specific codes after their introduction may account for some of the monthly increase in exposures observed in this study.

After a transient decrease from October through December 2012, the number of laundry detergent pod exposures continued to climb until peaking in April 2013, followed by a plateau and then decline, especially from August through December 2013. This observed decrease in the number of pod exposures may have been due to increased public awareness of the dangers of these products to young children due to efforts by the AAPCC, Centers for Disease Control and Prevention, American Academy of Pediatrics, and other organizations, as well as media coverage, including the publicity after the August 2013 death of a toddler after ingesting a laundry pod.[17,18] The decline in the frequency of laundry detergent pod exposures starting in April 2013 also may have been influenced by modifications made to pod packaging. In spring of 2013, Procter & Gamble (Cincinnati, OH), maker of Tide Pods (which has the largest market share of pods sold), introduced opaque product packaging.[18] Procter & Gamble continued to make other changes to its packaging throughout the summer of 2013, including adding a warning label and latches to the container. In August 2013, Procter & Gamble added a third latch to its packaging.[18] It is also possible that the observed decrease in the frequency of pod exposures was associated with the seasonal trend in the overall number of calls reported to PCCs, which peak during summer and decline during winter.

One- and 2-year-olds accounted for approximately two-thirds of cases in this study. These ages represent a developmental period of newfound mobility, exploration, curiosity, and teething. It is a time when children commonly place items in their mouths. One study that examined data from the Texas Poison Center Network found this same age pattern for laundry detergent pod exposures.[2] Our finding that ingestion is the most common route of exposure corroborates the results of other studies.[2,4,6]

Most patients in this study experienced only minor clinical effects from any route of exposure to laundry detergent pods, which generally agrees with findings from other studies in the United Kingdom and United States.[2,6] However, only approximately half (53.5%) of the exposures in this study were managed on site at a non–health care facility compared with 85.4% for all exposures reported to the NPDS during 2012 and 2013 among children younger than 6 years. Furthermore, compared with exposures overall, laundry detergent pod exposures required higher levels of care at health care facilities; they were more likely to be seen in a health care facility and treated and released (9.7% vs 35.4%), admitted to

TABLE 3 Clinical Effects Related to Laundry Detergent Pod Exposures Among Children Younger Than 6 Years by Exposure Route, NPDS 2012–2013

Clinical Effects	Single Route				Multiple Routes		Clinical Effect Total, *n* (%[a])
	Ingestion, *n* (%[a])	Ocular, *n* (%[a])	Dermal, *n* (%[a])	Aspiration, *n* (%[a])	Ingestion+[b], *n* (%[a])	Other[c], *n* (%[a])	
Cardiac effects							
Tachycardia	104 (0.8)	2 (0.2)	—	9 (15.3)	9 (0.5)	—	124 (0.7)
Dermal effects							
Erythema/flushed	91 (0.7)	34 (2.7)	49 (39.2)	1 (1.7)	95 (5.3)	50 (17.5)	320 (1.9)
Edema	26 (0.2)	140 (11.3)	9 (7.2)	—	66 (3.7)	45 (15.7)	286 (1.7)
Irritation/pain	31 (0.2)	55 (4.4)	38 (30.4)	—	71 (4.0)	33 (11.5)	228 (1.3)
Rash	105 (0.8)	5 (0.4)	27 (21.6)	—	83 (4.6)	7 (2.4)	227 (1.3)
Pallor	46 (0.3)	—	—	—	6 (0.3)	—	52 (0.3)
Burns (superficial)	5 (0.0)	8 (0.6)	12 (9.6)	—	16 (0.9)	5 (1.7)	46 (0.3)
Gastrointestinal effects							
Vomiting	7694 (56.0)	4 (0.3)	2 (1.6)	48 (81.4)	518 (29.0)	2 (0.7)	8269 (48.0)
Nausea	670 (4.9)	—	—	1 (1.7)	74 (4.1)	1 (0.3)	746 (4.3)
Oral irritation	478 (3.5)	3 (0.2)	—	2 (3.4)	83 (4.6)	1 (0.3)	567 (3.3)
Throat irritation	341 (2.5)	—	—	4 (6.8)	46 (2.6)	—	391 (2.3)
Diarrhea	296 (2.2)	—	—	1 (1.7)	33 (1.8)	—	330 (1.9)
Abdominal Pain	145 (1.1)	2 (0.2)	1 (0.8)	—	12 (0.7)	—	160 (0.9)
Dysphagia	25 (0.2)	—	—	—	4 (0.2)	—	29 (0.2)
Oral burns (including lips)	25 (0.2)	—	—	—	3 (0.2)	—	28 (0.2)
Oropharyngeal edema	25 (0.2)	—	—	—	2 (0.1)	—	27 (0.2)
Neurologic effects							
Drowsiness/lethargy	1074 (7.8)	3 (0.2)	—	13 (22.0)	106 (5.9)	3 (1.0)	1199 (7.0)
Agitated/irritable	120 (0.9)	8 (0.6)	—	4 (6.8)	31 (1.7)	1 (0.3)	164 (1.0)
Coma	24 (0.2)	—	—	3 (5.1)	3 (0.2)	—	30 (0.2)
Ocular effects							
Irritation/pain	129 (0.9)	971 (78.4)	2 (1.6)	—	552 (30.9)	226 (79.0)	1880 (10.9)
Red eye/conjunctivitis	68 (0.5)	627 (50.6)	—	—	329 (18.4)	132 (46.2)	1156 (6.7)
Lacrimation	17 (0.1)	154 (12.4)	—	—	50 (2.8)	36 (12.6)	257 (1.5)
Corneal abrasion	19 (0.1)	145 (11.7)	—	—	48 (2.7)	26 (9.1)	238 (1.4)
Burns	5 (0.0)	34 (2.7)	—	—	18 (1.0)	9 (3.1)	66 (0.4)
Photophobia	1 (0.0)	22 (1.8)	—	—	6 (0.3)	8 (2.8)	37 (0.2)
Respiratory effects							
Cough/choke	1998 (14.6)	1 (0.1)	2 (1.6)	39 (66.1)	249 (13.9)	1 (0.3)	2290 (13.3)
Dyspnea	171 (1.2)	—	—	10 (16.9)	18 (1.0)	—	199 (1.2)
Bronchospasm	120 (0.9)	—	—	7 (11.9)	11 (0.6)	—	138 (0.8)
X-ray findings(+)	89 (0.6)	—	—	16 (27.1)	7 (0.4)	—	112 (0.7)
Hyperventilation/tachypnea	73 (0.5)	—	—	6 (10.2)	2 (0.1)	—	81 (0.5)
Respiratory depression	60 (0.4)	—	—	6 (10.2)	2 (0.1)	—	68 (0.4)
Pneumonitis	23 (0.2)	—	—	6 (10.2)	3 (0.2)	—	32 (0.2)
Miscellaneous effects							
Other	629 (4.6)	75 (6.1)	2 (1.6)	19 (32.2)	138 (7.7)	20 (7.0)	884 (5.1)
Excess secretions	207 (1.5)	8 (0.6)	—	10 (16.9)	27 (1.5)	1 (0.3)	253 (1.5)
Fever/hyperthermia	78 (0.6)	—	—	5 (8.5)	8 (0.4)	—	91 (0.5)
Acidosis	42 (0.3)	—	—	4 (6.8)	3 (0.2)	—	49 (0.3)
Exposure route total	13 730	1238	125	59	1788	286	17 230

Only clinical effects with a number of cases representing ≥0.2% of all exposures are presented in this table. —, no clinical effect.

[a] Percentages relate to each exposure route total and will not sum to 100.0%, because some patients experienced none or more than 1 clinical effect.

[b] Ingestion+ includes multiple exposure routes with ingestion.

[c] Other includes multiple exposure routes without ingestion.

a non–critical care unit (0.8% vs 2.4%), and admitted to a critical care unit (0.6% vs 2.0%). More than 700 children were admitted to the hospital and experienced serious clinical effects in this study. Less common, but very serious, clinical effects involved the central nervous system and respiratory system, including coma, seizure, pulmonary edema, and respiratory arrest. There were 2 deaths. A total of 102 children in the current study required tracheal intubation after oral exposure. These findings agree with several case studies that reported children with depressed level of consciousness, trouble breathing, pleural effusion, aspiration pneumonia, and other symptoms requiring tracheal intubation and mechanical ventilation after laundry detergent pod ingestion.[1,4–6]

Although ingestion of laundry detergent pod contents clearly results in the most serious clinical effects, eye injury also can occur with ocular exposure. European and Canadian reports, in particular, have described corneal abrasions and burns when ocular exposure

TABLE 4 Therapies Used in Laundry Detergent Pod Exposure Cases Among Children Younger Than 6 Years by Route of Exposure, NPDS 2012–2013

Therapy	Single Route				Multiple Routes		Therapy Total, *n* (%[a])
	Ingestion, *n* (%[a])	Ocular, *n* (%[a])	Dermal, *n* (%[a])	Aspiration, *n* (%[a])	Ingestion+[b], *n* (%[a])	Other[c], *n* (%[a])	
Dilute/irrigate/wash	9730 (70.9)	1156 (93.4)	111 (88.8)	32 (54.2)	1628 (91.1)	277 (96.9)	12 937 (75.1)
Food/snack	1542 (11.2)	6 (0.5)	3 (2.4)	4 (6.8)	212 (11.9)	4 (1.4)	1773 (10.3)
Other	782 (5.7)	139 (11.2)	22 (17.6)	7 (11.9)	118 (6.6)	38 (13.3)	1106 (6.4)
Antibiotics	69 (0.5)	174 (14.1)	6 (4.8)	7 (11.9)	78 (4.4)	41 (14.3)	375 (2.2)
Fluids, IV	321 (2.3)	—	—	18 (30.5)	22 (1.2)	1 (0.3)	362 (2.1)
Antiemetics	207 (1.5)	2 (0.2)	—	2 (3.4)	15 (0.8)	—	226 (1.3)
Other emetic	170 (1.2)	—	1 (0.8)	—	21 (1.2)	1 (0.3)	193 (1.1)
Oxygen	153 (1.1)	—	—	17 (28.8)	14 (0.8)	—	184 (1.1)
Bronchodilators	133 (1.0)	—	—	10 (16.9)	11 (0.6)	—	154 (0.9)
Steroids	102 (0.7)	7 (0.6)	4 (3.2)	2 (3.4)	26 (1.5)	2 (0.7)	143 (0.8)
Intubation	82 (0.6)	—	—	10 (16.9)	10 (0.6)	—	102 (0.6)
Ventilator	77 (0.6)	—	—	10 (16.9)	9 (0.5)	—	96 (0.6)
Antihistamines	41 (0.3)	6 (0.5)	8 (6.4)	—	16 (0.9)	1 (0.3)	72 (0.4)
Calcium	61 (0.4)	—	1 (0.8)	—	4 (0.2)	—	66 (0.4)
Sedation, other	43 (0.3)	2 (0.2)	—	10 (16.9)	10 (0.6)	—	65 (0.4)
Benzodiazepines	26 (0.2)	3 (0.2)	—	3 (5.1)	4 (0.2)	1 (0.3)	37 (0.2)
Charcoal, single dose	11 (0.1)	—	—	—	—	—	11 (0.1)
Fresh air	7 (0.1)	—	—	1 (1.7)	1 (0.1)	—	9 (0.1)
Neuromuscular blocker	6 (0.0)	—	—	3 (5.1)	—	—	9 (0.1)
Alkalinization	5 (0.0)	—	—	2 (3.4)	—	—	7 (0.0)
Vasopressors	5 (0.0)	—	—	—	—	—	5 (0.0)
Ipecac	4 (0.0)	—	—	—	—	—	4 (0.0)
Naloxone	4 (0.0)	—	—	—	—	—	4 (0.0)
Atropine	2 (0.0)	1 (0.1)	—	—	—	—	3 (0.0)
Anticonvulsants	2 (0.0)	—	—	—	—	—	2 (0.0)
Cathartic	1 (0.0)	—	—	—	—	—	1 (0.0)
CPR	—	—	—	1 (1.7)	—	—	1 (0.0)
Fomepizole	1 (0.0)	—	—	—	—	—	1 (0.0)
NAC, IV	1 (0.0)	—	—	—	—	—	1 (0.0)
Exposure route total	13 730	1238	125	59	1788	286	17 230

CPR, cardiopulmonary resuscitation; IV, intravenous; NAC, N-Acetylcysteine; —, no therapy performed.

[a] Percentages relate to each exposure route total and will not sum to 100.0%, because some patients received none or more than one of these therapies.

[b] Ingestion + includes multiple exposure routes with ingestion.

[c] Other includes multiple exposure routes without ingestion.

occurs.[11,12] In the current study, corneal abrasions and ocular burns occurred in more than 14% of cases with ocular exposure.

Among cases that reported the scenario associated with the child's access to the laundry detergent pods, 42.3% (382 of 904) indicated that the pods were stored within sight of the child or always left out. The colorful, candylike designs of the pods may have played a role in some of these exposures, but further research is needed to determine whether these features indeed increase their appeal to young children. Opaque, child-resistant containers may help prevent child access to the laundry detergent pods inside. Recent declines in laundry detergent pod exposures are associated temporally with introduction of packaging changes by one manufacturer; however, it is not clear that the pod containers of any brand currently on the market are truly child resistant. Standards are needed to help ensure that all manufacturers of laundry detergent pods adopt safer packaging for their products to decrease child exposure. This includes packaging of the actual detergent pod as well as container packaging. ASTM International has already begun discussions on such a standard.[19]

There is need for further research into the chemical composition of laundry detergent pods and determination of the ingredients or ingredient concentrations that are most responsible for the observed toxic effects. Various ingredients in detergent pods have been postulated to cause the symptoms associated with ingestion, including ethoxylated alcohols and propylene glycol, which are ingredients found in many laundry detergents.[1] However, it is not known why the clinical effects seem to be more severe for laundry detergent pods than traditional liquid laundry detergent exposures. Through constituent reformulation, a less-toxic form of laundry detergent pods may be possible without sacrificing cleaning effectiveness. An example of successful constituent reformulation was the reformation of fabric cleaners, with replacement of benzene

with safer aliphatic chlorinated hydrocarbons.[20,21]

Additional prevention measures include public awareness and education efforts, as well as product labeling, including the use of uniform warning icons on all laundry detergent pod products. Pediatricians and other health care providers should counsel parents and other child caregivers about the dangers of detergent pod exposure and the need for safe storage and careful use of these products. In this study among cases that reported the scenario associated with the child's access to the laundry detergent pods, almost one-fourth (22.9%; 75 of 327) of the exposures were associated with the pods being stored inappropriately, stored in a low unlocked kitchen or bathroom cabinet, or the pod container was in use and temporarily left open while the caregiver was momentarily distracted. Households with children younger than 4 years should be encouraged to use traditional laundry detergent products rather than laundry detergent pods.

This study has a number of limitations. The numbers reported in this study underestimate the true magnitude of laundry detergent pod exposure among young children in the United States, because the NPDS captures cases only voluntarily reported to member PCCs. Other cases may be treated in health care facilities or private physician offices without a report being made to a PCC, and some children may not receive medical attention. Data miscoding is another potential limitation; for example, the case admitted to a psychiatric facility in this study may have had a miscoded child's age or level of health care received. In addition, any delay in the adoption of use of the new generic and specific codes for laundry detergent pods by PCCs would have underestimated the number of exposures during the early months of the study period. Additionally, uncommon clinical effects may not be coded with the same fidelity as common ones, which could lead to erroneous inferences. NPDS data are based on self-reports from parents, child caregivers, and health care professionals, and cannot be completely verified by the AAPCC or the reporting PCC. In addition, the scenario associated with the child's access to the laundry detergent pods is an optional reporting field in the NPDS and was documented in only 5.2% of cases in this study, which limits interpretation. Despite these limitations, the NPDS is a large national database with data obtained by certified poison control experts by using established quality controls and patient follow-up. It is the most comprehensive and accurate database available for investigation of the important public health problem of laundry detergent pod exposure among US children.

CONCLUSIONS

Laundry detergent pods are new products in the US marketplace that pose a serious poisoning risk to young children. This nationwide study underscores the need for increased efforts to prevent exposure of young children to these products, which may include improvements in product packaging and labeling, development of a voluntary product safety standard, and public education. Product constituent reformulation is another potential strategy to mitigate the severity of clinical effects of laundry detergent pod exposure.

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