

Exposures to Single-Use Detergent Sacs Reported to a Statewide Poison Control System, 2013–2015

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Background: Single-use detergent sacs (SUDSs) represent a relatively new household hazard to children. Brand differences and packaging changes may contribute to differential risks with accidental exposure. We sought to identify high-risk features from SUDS exposures in children and to assess whether product packaging changed trends in SUDS exposures reported to poison centers.

Methods: In this institutional review board–approved, retrospective chart review of SUDS exposures from January 2013 to August 2015, deidentified case records of a large statewide poison control system were extracted and analyzed for clinical associations and trends. Clinical and demographic data were gathered, and outcomes were analyzed for differences by brand type, presenting complaints, and occurrence in relation to SUDS packaging changes.

Results: There were 3502 SUDS exposures, with 3343 (95%) in children 5 years or younger. Metabolic, central nervous system, and pulmonary effects were significantly associated with moderate or severe outcome ($P < 0.05$). Forty patients received invasive procedures such as endoscopy, bronchoscopy, and/or endotracheal intubation, and more than half had mucosal lesions discovered by the diagnostic procedure. The presence of stridor, wheezing, drooling, lethargy, and exposure to the brand All Mighty Pacs were all significant predictors of moderate or severe outcome ($P < 0.05$). After the implementation of packaging changes, there was a transient decline in the number of exposures to the Tide Pods product.

Conclusion: Central nervous system and respiratory effects as well as certain brand types predict serious outcomes from SUDS exposures. Manufacturing changes had a brief beneficial effect on the volume of SUDS exposures reported between 2013 and 2015.

Key Words: laundry detergent sacs, poisoning, poison control, toxicology (*Pediatr Emer Care* 2018;00: 00–00)

Single-use detergent sacs (SUDSs) were first introduced into the US market in 2010. Single-use detergent sacs are small, water-soluble packages that contain highly concentrated liquid detergent. Manufactured with vibrant colors, they are mistaken as candy or toys by small children, who may accidentally mouth or ingest their contents.¹ The sacs dissolve upon contact with moisture and, as a result, pose a high risk for accidental toxic exposures.^{2–4}

Since the introduction of laundry detergent sacs, there has been an increased incidence of SUDS-related toxic exposures. As a result, in May 2012, the American Association of Poison Control Centers (AAPCC) began tracking and characterizing exposures.¹ In the first month after the AAPCC began tracking cases, 485 cases of laundry detergent exposures were recorded, in which 454 cases (95%) involved children younger than 5 years.¹ Subsequent studies confirmed these initial indications that

children were a high-risk group: in cases reported from March 2012 to April 2013, the National Poison Data System (NPDS) recorded more than 17,000 cases of children 6 years or younger being exposed to laundry detergent sacs.⁵ The NPDS Annual Reports from 2012 to 2014 demonstrate more than 90% of cases occurring in children 5 years or younger for each year.^{5–7} We previously published a retrospective review of 804 cases reported to the California Poison Control System (CPCS).⁸ Of the different adverse effects reported, central nervous system (CNS) and respiratory effects were found to be the most accurate predictor of moderate to severe clinical outcomes. In addition, that study found that All Mighty Pacs and Purex Ultrapacks exposures were more likely to result in moderate or severe outcomes.

It is unclear what causes SUDS toxicity, but it is apparent that these products are more hazardous than detergents marketed in bulk quantities as liquids or granules. Both physical and chemical properties may be responsible for the greater severity of clinical effects observed in some cases. Following a 2013 case report of 4 pediatric patients with SUDS-induced toxicity requiring airway intervention, a gas chromatography–mass spectrometry analysis revealed that SUDSs have a higher concentration of surfactant components compared with liquid detergents.⁹ Another study demonstrated that some sacs burst more easily than others, a characteristic that may also contribute to the risk for more severe outcomes following accidental toxic exposure.¹⁰ Given differences in formulation and concentrations between conventional laundry detergent products and SUDS products, traditional management for non-SUDS exposures may not be as effective in SUDS exposures.¹¹

Increased media coverage and public health agency concerns about cases reported in the first few years of commercial availability in the United States prompted some manufacturers to change the product packaging in an attempt to reduce exposures. In July 2012, Procter & Gamble (P&G) started manufacturing double-latched lids and eventually transitioned to triple-latched lids in August 2013. In addition, P&G changed its outer packaging to a more opaque and less vibrant covering in spring of 2013 in order to hide the visually appealing SUDS product from children. Even with the recent changes, 2 pediatric deaths have resulted due to SUDS exposure. Procter & Gamble continues to implement other packaging changes and promote increased awareness regarding the dangers of Tide Pods to children.

The purpose of this retrospective study was to investigate trends in SUDS exposures, specifically whether exposure numbers were affected by packaging changes, and characteristics of high-risk encounters with SUDS leading to moderate or severe outcomes.

METHODS

This institutional review board–approved study is a retrospective chart review of SUDS exposures reported to CPCS between January 2013 and August 2015. Deidentified cases were extracted from the electronic medical record of CPCS (Visual DotLab) using the following search terms: laundry pods, the AAPCC product-specific codes for Tide Pods, Purex Ultrapacks, All Mighty Pacs,

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Gain Flings, and a unique agent code (AAPCC ID: 6903138; generic: 077900) created by the AAPCC to track SUDS exposures. Cases were included unless they met these exclusion criteria: nonhuman ingestion, informational calls, non-SUDS exposure, and cases containing only demographic information but lacking clinical data.

The information extracted from these cases included the following: patient's age and sex, location of exposure, route of exposure, product's brand name, observed clinical effects, patient disposition, therapeutic management, and severity of outcome. Observed clinical effects were subdivided into major clusters or general physiologic classes and included gastrointestinal (GI) (eg, nausea, vomiting, diarrhea), airway (eg, respiratory distress, stridor, wheezes, rales, or tachypnea), CNS (confusion, somnolence, or seizures), ocular/dermal (skin or eye irritation, rash, or other relevant findings), and metabolic (abnormalities in chemistry panel results including serum glucose, bicarbonate, lactic acid, liver function tests, or creatinine). Abstraction of data was performed by 4 pharmacy students entering data into MS XL spreadsheet containing all the relevant data fields. A mean κ score of 0.82 was obtained in the first 3% of all coded cases. Predictive Analytics Software Statistics (IBM

SPSS, Inc, Chicago, Ill) was utilized to obtain κ scores, descriptive statistics, χ^2 tests, and binary logistic regressions.

RESULTS

From January 2013 to March 2015, there were 3502 cases of SUDS exposures identified from CPCS records after exclusion criteria were applied for 241 charts.

Demographic Information and Clinical Factors

Demographic information and clinical factors of the cases are shown in Table 1. Nearly all exposures (3485 [99.5%]) occurred at home, and the majority of exposures occurred via the oral route. Children 5 years or younger were affected in 3308 exposures (94.4%). There was a nearly even gender distribution, with 1739 males (49.6%) and 1759 females (50.2%) in the cases reported. With regard to specific brands, Tide Pods appeared to be the predominant SUDS product encountered, accounting for 2182 cases (65.3%).

Regarding clinical effects and their severity, the majority of cases (82%) had either no effect or a minor effect. A total of 1341 exposures (38.3%) resulted in no reported effect. The most frequently reported clinical effects were GI symptoms and signs and affected 1801 exposures (51.5%). The second most commonly affected organ system was airway/pulmonary, followed by ocular and CNS, respectively. There were no deaths reported during this study period.

TABLE 1. Demographic Information and Clinical Factors Reported Based on Number and Percentages of Exposures

	Cases (%)
Brand name of SUDS*	
Tide Pods	2182 (62.3)
All Mighty Pacs	253 (7.2)
Purex Ultrapacks	113 (3.2)
Gain Flings	205 (5.9)
Grocery Store Generics	27 (0.8)
Warehouse Generics (Costco/Sam's Club)	106 (3.0)
Unknown	572 (16.3)
Route of exposure [†]	
Ingestion	2982 (79.7)
Dermal	58 (1.5)
Ocular	462 (12.3)
Clinical effects [‡]	
GI	1,801 (51.5)
Asymptomatic	1341 (38.3)
Airway/pulmonary	495 (14.2)
Ocular	437 (12.5)
CNS	244 (7.0)
Dermatologic	64 (1.8)
Cardiac	47 (1.3)
Metabolic	41 (1.2)
Outcomes	
No effect	1021 (29.2)
Minor effect	1843 (52.6)
Moderate effect	103 (2.9)
Severe effect	18 (0.5)
Death	0 (0)
Unrelated	61 (1.7)
Unknown/lost to follow-up	456 (13)

No. of exposures, n = 3502 (%).

*A small number of cases involved more than 1 brand name of SUDS.

[†]Some cases may have multiple routes of exposure.

[‡]A single case often had multiple clinical effects.

Relationship Between Clinical Effects and Outcome Severities

We sought to identify which organ system effects were more predictive of moderate and severe outcomes, using the 4 most frequently reported classes of clinical effects (airway/pulmonary, GI, metabolic, and CNS). Of all the cases with metabolic effects, 82.9% resulted in either a moderate or severe outcome. Central nervous system and airway/pulmonary effects had similar predictive associations, with 13.5% of all moderate or severe cases resulting in CNS effects and 12.7% resulting in airway/pulmonary effects. Lastly, GI effects appear to contribute the least to moderate or severe outcome, with only 4.7% of all cases involving GI effects resulting in either a moderate or severe outcome. A χ^2 analysis showed that a statistically significant relationship exists between these clinical effects and outcomes ($P < 0.05$). Further analysis with binary logistic regression identified that metabolic, CNS, and airway/pulmonary effects were significant predictor variables for moderate or severe outcome ($P < 0.05$).

Relationship Between Brands and Outcome Severities

Cases with moderate or severe outcome were also classified by SUDS brand type, if reported. The All Mighty Pacs product had the highest proportion of adverse outcomes; 23 (9.1%) of 253 exposures to this product resulted in moderate or severe outcome. Further analysis with binary logistic regression identified that All Mighty Pacs was a significant predictor variable for moderate or severe outcome ($P < 0.05$). There were different rates of moderate/severe outcomes associated with other SUDS brand types, but all brands had at least 1 moderate/severe outcome associated; Costco/Sam's Club had 7 (6.6%) of 106 cases, grocery store generics had 1 (3.7%) of 27 cases, Purex Ultrapacks had 4 (3.5%) of 113 cases, Gain Flings had 7 (3.4%) of 205 cases, and Tide Pods had 58 (2.4%) of 2182 cases. A χ^2 analysis controlling for number of exposures per brand showed a statistically significant rate of moderate/severe outcomes for each SUDS brand identified ($P < 0.05$).

Temporal Trends in SUDS Exposures

Looking at the total number of SUDS exposures by month, exposures increased gradually and peaked in June 2014 before gradually declining thereafter. After the implementation of opaque packaging in spring 2013 by P&G for Tide Pods, there was a small, transient drop in call volume for Tide Pod exposures, until the end of spring 2013. With the implementation of triple-latched lids for the Tide product, in August 2013, a decrease in all SUDS exposures was similarly observed, but within 3 months returned to the preimplementation baseline call volume. Prior to the implementation of triple-latched lids, CPCS received an average of 69 Tide Pods cases per month from January 2013 to August 2013. After the implementation of triple-latched lids, an average of 68 Tide Pods cases were reported per month from August 2013 to August 2015.

Intubation, Endoscopy, and/or Bronchoscopy

We also examined the incidence of invasive procedures (endotracheal intubation, bronchoscopy, or endoscopy) performed in patients following exposure to SUDS products. Route of exposure was oral for all cases requiring endoscopy, bronchoscopy, or intubation. All exposures were unintentional/exploratory and happened at home, except for 1 case. Of the 121 cases with moderate or severe effects, 16 (13%) were intubated, 16 (13%) had endoscopy, 2 (0.2%) had bronchoscopy, and 6 (0.5%) had both endoscopy and bronchoscopy. Of those requiring intubation, 9 of 16 also had another procedure (either endoscopy or bronchoscopy) performed.

Most patients requiring intubation were 3 years or younger (15 [94%]), and 13 children were 1 year or younger. One adult was intubated and was noted to have a history of developmental delay. Males comprised 66% (16/24) of the patients requiring either endoscopy or bronchoscopy, and 56% (9/16) of the patients required intubation. All patients requiring endoscopy or bronchoscopy were 3 years or younger, and 22 of 24 were 1 year or younger.

Injuries to airway or GI tract were commonly found during these procedures. Esophageal or gastric lesions were reported in 13 (59%) of 22 patients who underwent endoscopy. Of the remainder, 4 (18%) were reported to be normal or negative for injuries, and 5 (23%) case records had no endoscopy results available. Similarly, 5 (62%) of 8 bronchoscopies showed injury to the airway; 2 (25%) showed no injury; and 1 had no result available, although the physical examination in the emergency department noted the presence of blisters in the throat.

Nine (37%) of 24 patients who underwent endoscopy or bronchoscopy ingested Tide Pods, 5 (20%) ingested All Mighty Pacs pods, 5 (20%) ingested unknown SUDS, 1 (4%) each of Purex, Gain Flings and Grocery Store Generic. Of the 16 patients requiring intubation, 6 (37%) ingested Tide Pods; 4 (25%) ingested All Mighty Pacs pods, 2 (12%) ingested Purex pods, 1 each ingested Gain Flings and Grocery Store Generic pod, and 2 (12%) ingested an unknown SUDS.

Physical signs and symptoms related to airway injury or vulnerability were frequently correlated with invasive procedures. Lethargy was present in 9 (56%) of 16 cases requiring intubation, and 5 cases required either endoscopy or bronchoscopy. For comparison, the total number of cases with lethargy reported as a symptom was 32 (<1%) of 3504 exposures. Four (25%) of 16 cases requiring intubation had stridor as a presenting symptom, and 3 (19%) of 16 had wheezing. The total numbers of cases with either stridor or wheezing were 14 (<1%) and 31 (<1%), respectively. Six of 16 cases that required endoscopy had drooling as a presenting symptom (37%), with 2 also requiring bronchoscopy (25% of all bronchoscopies). The total number of cases with drooling as one of the reported symptoms was 53 (1.5%) (Figs. 1 and 2).

DISCUSSION

Since the introduction of SUDSs into the US market in 2010, adverse effects of these products in children have been increasingly reported.¹² These products appear to cause higher rates of clinical effects, hospitalization, and serious medical outcomes in comparison to conventional laundry detergent formulations.^{13,14} Consequently, the NPDS began tracking SUDS exposures and found a steady increase, from 8653 cases in 2012 to 10,877 cases in 2013 and 12,686 cases in 2014, with the majority of these exposures occurring in children 5 years or younger.^{6,7} Most of these cases occurred in young children, and the clinical effects ranged from mild to life threatening. These trends from the United States and reports from the United Kingdom and Europe demonstrate that although the majority of SUDS-related toxic exposures resulted in minor clinical effects, some exposures lead to severe clinical effects and require prompt intervention.^{15,16} In this study, we identified a large sample of children exposed to SUDSs and risk factors associated with a minority of cases resulting in severe outcomes.

Compared with a similar earlier study with 804 patients, we found that exposure characteristics maintained similar patterns in this case series of a substantially larger sample size.⁸ Although

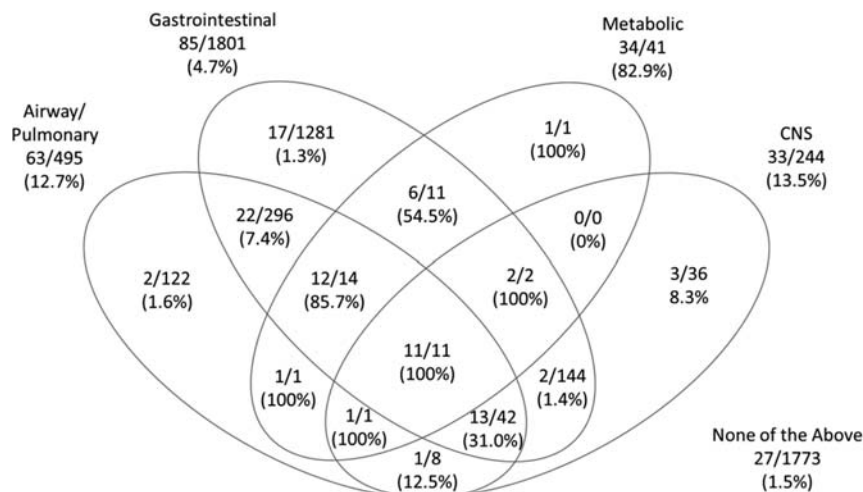


FIGURE 1. Frequency of clinical effects in cases with moderate or severe outcomes.

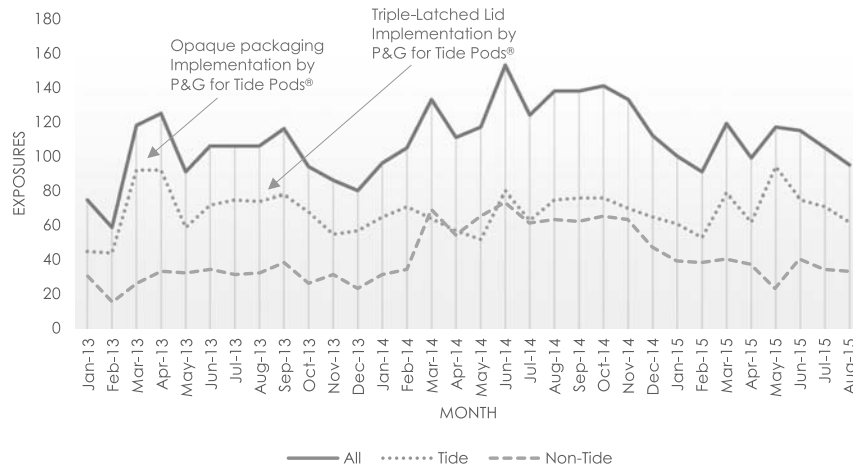


FIGURE 2. Trend in SUDS exposures comparing all brand types versus Tide Pods only versus all non-Tide Pods brands (non-Tide).

proportions may have shown minor increases or decreases, the most common brand encountered remains Tide Pods, the most common route of exposure is through ingestion, the most common clinical effect is GI, and the most common clinical outcome is minor. A small difference from the previous study is the proportion of Tide Pods encountered; 72% of exposures were due to Tide Pods in the previous study, whereas 69% were due to Tide Pods in this study. The dip in Tide Pods exposures may be the result of several factors, such as a decreasing market share due to the introduction of newer brands to market¹¹ or to safety packaging changes made by the company.

Our investigation also found that CNS and respiratory effects remained significantly correlated with moderate or severe outcomes. This is somewhat expected, as the combination of CNS and/or respiratory effects may potentially lead to airway compromise and the need for airway protection, either of which outcome is coded as moderate to severe. The clinical practice lesson from this finding is that, for patients demonstrating these complaints early in the clinical encounter, a more aggressive intervention approach may be necessary to manage their symptoms. In this study, we found a third factor, metabolic effects, to also be a predictor of moderate or severe outcomes. However, it may not be as useful a predictor variable because of the difficulty of assessing metabolic effects in the home environment where the majority of exposures occur.

In this study, the relationships between brands and outcomes were also assessed. Similar to the previous study, the All Mighty Pacs product remained significantly correlated with more serious outcomes. This may be due to the differences in packaging and composition of SUDS products. While our previous study also showed significant correlation with Purex Ultrapacks, that result was not replicated in the current study. This may be due to the previous study having a limited sample size for Purex Ultrapacks exposures.

Finally, we assessed trends in outcomes related to packaging interventions designed at curbing SUDS exposures. In an attempt to reduce harm related to SUDS exposure, some manufacturers have introduced packaging changes and consumer education.^{17,18} The manufacturer for Tide Pods announced various packaging changes such as double-latched lids, triple-latched lids, and more opaque packaging. However, our findings suggest that these changes do not appear to affect the trend in SUDS-related exposures substantially. Between January 2013 and August 2015, the average number of SUDS-related exposures remained similar before and after the implementation of the triple-latched lid for Tide Pods. Previous publications from Europe and the United Kingdom have reported different success rates with various attempts at curbing exposures with

packaging changes,^{15,16} and further study is required to clarify which preventive strategies and packaging changes are most effective. It is important to note that numbers after manufacturing changes may not necessarily correlate with the changes to packaging; consumer purchases may have occurred prior to the packaging change, while the actual date of exposure occurred afterward. Overall, SUDS-related exposures continued to increase, despite multiple efforts at exposure mitigation by manufacturers. Because of the growing popularity in SUDS products, we can expect that SUDS exposure will remain on the rise until more changes by manufacturers are implemented.

This study confirms prior case reports and small case series suggesting a high rate of hospital admission and invasive procedures being performed in very young children who are exposed to SUDS products.^{19–21} Endoscopy, bronchoscopy, and endotracheal intubation were performed in approximately 1% of the total study population and in one third of those who were coded as having moderate to severe outcomes. Furthermore, more than half of all endoscopy and bronchoscopy results were positive for lesions consistent with corrosive injuries, a high rate of injury that is similar to other recent case series of detergent pod ingestion.²² Taken together, these findings confirm other recent work that SUDSs are much more hazardous than conventional detergent products.²³

While our study was not designed to predict which clinical effects would be associated with mucosal injury on endoscopy or bronchoscopy, we were able to make several correlations based on our data. The physical findings of lethargy, stridor, wheezing, and drooling were associated with those who went on to require these invasive procedures, and this may guide a clinical approach to risk stratification. We suggest that the absence of these signs confers a lower risk for mucosal injuries and may identify a subset of patients in whom bronchoscopy or endoscopy may not be necessary. As experience with these exposures accumulates, prospective studies will clarify the most predictive clinical effects in young children exposed to these products.

In the meantime, complications from pediatric exposure to SUDSs remain a complex issue, which will require a multifaceted solution. To curtail these exposures and their clinical complications, we advocate for continued parent and consumer education about the dangers of these products, evidence-informed clinical guidelines to help risk-stratify cases, and effective changes at the manufacturer and retail levels. Given the spectrum of clinical outcomes ranging from asymptomatic to acutely life-threatening conditions, the present study adds to the current knowledge about how to distinguish which clinical effects are better predictors for

more moderate or severe outcomes. Development of evidence-informed guidelines based on this and similar work can help prevent unnecessary emergency room visits for low-risk SUDS exposure cases, while appropriately referring the more moderate or severe SUDS exposure cases for proper management. This will further reduce health care costs while optimizing care for those who truly require medical intervention.

LIMITATIONS

As with other poison control data, a limitation of this study involves data collection and interpretation by pharmacists who have special training and certification to work at poison control centers. Although these poison specialists follow the NPDS coding standard to ensure coding consistency, variability and subjectivity may still exist. In addition, objective data such as laboratory and vital sign values were obtained from a secondary source (ie, reported by a nurse or physician versus directly from the electronic medical record), possibly resulting in misreported data. Cases may also have incomplete data because of missing or unchecked laboratory or imaging results, or the patient may have been lost to follow-up. Lastly, all poison retrospective studies involving poison control center data are subject to underreporting (due to the voluntary nature of calls made to report exposures) and overreporting (because serious exposures are more likely to be reported than benign or asymptomatic cases). Another source of underreporting is that some SUDS manufacturers may list consumer help lines for first aid or safety information on their retail packaging, thereby diverting exposure data from poison control centers. Despite these limitations, our study included a very large and robust sample size that allowed us to find clinical factors that correlate to severity outcome and help guide the management of SUDS exposure.

CONCLUSIONS

Despite increasing awareness and efforts to reduce exposures, our study confirms that children remain at high risk for complications related to SUDS exposures. Efforts made by SUDS manufacturers to minimize exposures resulted in a weak and transient decrease in SUDS exposures between 2013 and 2015, and further efforts and investigations are needed to identify best practices with preventive strategies. Further studies and expert consensus are also required to develop a standardized, evidence-informed guideline on workup and management for this hazardous set of products. Consumers and health care providers should take into consideration the presence of high-risk features, such as respiratory or CNS system involvement, and in some cases product brand type when deciding on the most appropriate course of action after a SUDS exposure. Physical signs of mucosal irritation such as drooling, wheezing, and stridor, as well as decline in mental status, suggest a higher risk for morbidity from exposure to SUDS.

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