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ORIGINAL ARTICLE

Dark side of laundry pods: Analysis of exposure to laundry detergent capsules in children

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Aim: We aimed to evaluate the epidemiological characteristic and clinical features of laundry detergent capsule (LDC) exposure in children.

Methods: Retrospective review of medical records of patients hospitalised due to the exposure to LDC at the Department of Paediatrics and Gastroenterology, Medical University of Lublin, Poland, from 2014 to 2019 was conducted.

Results: During the study period, 38 children including 19 (50%) boys and 19 (50%) girls were admitted to our department due to exposure to LDC. The age of patients ranged from 11 months to 9 years, with a mean 48.61 ± 28.85 months of age. About 66% of patients were younger than 5 years. The major route of exposure was ingestion ($n = 37$; 97%). Most patients ($n = 27$; 71%) exhibited symptoms of exposure to the LDC. The most common symptoms were vomiting ($n = 23$; 60%), cough ($n = 7$; 18%) and salivation ($n = 5$; 13%). Seven patients required gastroscopy. Abnormalities were subsequently identified in three children.

Conclusions: Accidental exposure to LDC usually occurs in children younger than 5 years. Although the majority of cases had mild or moderate clinical outcomes, ingestion of LDC may lead to some severe consequences. Improvements in parental education regarding the risks of LDC, and in the packaging of LDC may prevent serious injury.

Key words: caustic ingestion; childhood; detergent; laundry detergent pod; poisoning.

What is already known on this topic

1 Ingestion of laundry detergent capsules (LDCs) leads to more serious clinical effects than of traditional liquid laundry detergent.
2 There are currently no guidelines or recommendations regarding the management of children after LDC ingestion.

What this paper adds

1 Children younger than 5 years are at risk of ingesting LDC.
2 Ingestion of the contents of the LDCs can lead to serious consequences such as severe chemical injury of the oesophagus.

Poisonings remain a serious issue in health care.[1,2] Household cleaning products are among the top five most common toxic exposures.[3] According to the Organisation for Economic Co-operation and Development (OECD), 16 000 poisoning cases with laundry detergent capsules (LDCs) are reported every year.[4] Recently, household washing powders and liquids have been increasingly replaced by LDC. LDCs include a small amount of concentrated detergent (usually 32–43 mL) encapsulated in a polyvinyl alcohol membrane that is soluble in water. Most capsules available in the market consist of anionic, non-ionic detergents, propylene glycol and ethanol. Depending on the manufacturer of the detergent, the pH of the capsule content is between 7 and 9. Single and multi-component capsules are available.[3,5]

Capsules, because of their bright colour, pleasant smell and small size, can be easily confused by children with candies, toys or teethers. Exposure can occur by ingestion or through contact of the capsule contents with the skin and mucous membranes. Exposure to LDC leads to more serious clinical effects than contact with traditional liquid laundry detergent due to the higher concentration of detergents inside the capsule.[6,7] Furthermore, due to the water solubility of the capsule membrane, its contents may be released as a result of contact with wet hands or saliva of the child.[6] Toxicity is mainly caused by non-ionic surfactants. Depending on the route of exposure, adverse reactions of the skin, eyes, digestive and respiratory system may occur.[3,6,8]

To the best of our knowledge, no scientific papers have been published on LDC exposure for children in Poland. No guidelines have been developed for management after exposure to LDC. We aimed to assess clinical features of exposure to LDC in children.

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Methods

We reviewed medical records of patients hospitalised in the Department of Paediatrics and Gastroenterology at the Medical University of Lublin, Poland, from 1 January 2014 to 31 December 2019 due to poisonings and selected children who were admitted due to the exposure to LDC. The analysis included patients' age, gender, place of residence, type of capsules, symptoms after exposure, results of additional tests and treatment.

The statistical study was carried out using the Statistica version 13 program (StatSoft, Poland). The Mann–Whitney U test was used to compare the two independent groups. To assess the existence of differences between the compared groups or the existence of relationships between the analysed non-measurable parameters, a homogeneity or χ^2 test of independence for qualitative features was used. For small numbers (below 5) in the examined subgroups, Yates's correction for continuity was used. The level of significance was $P < 0.05$. The study was approved by the Bioethics Committee at the Medical University of Lublin (No. KE-0254-116-2020).

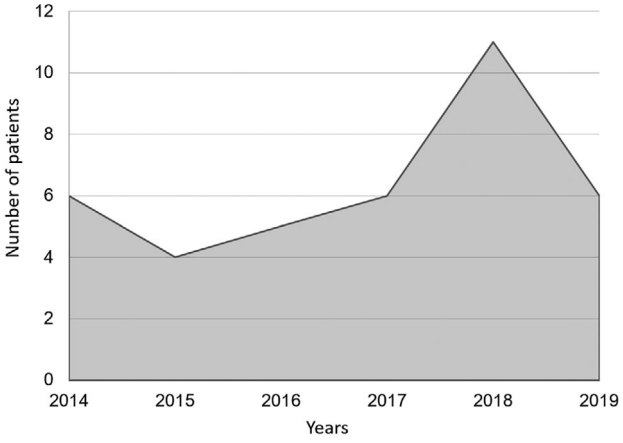

Fig. 1 The number of children hospitalised during the years 2014–2019 in the Department of Paediatrics and Gastroenterology of Medical University of Lublin.

Results

From 1 January 2014 to 31 December 2019 in the Department of Paediatrics and Gastroenterology Medical University of Lublin, there were 899 patients hospitalised due to poisoning. Thirty-eight of these were due to exposure to LDC. Figure 1 shows the number of children hospitalised in individual years. The study group included 19 (50%) boys and 19 (50%) girls. Patients age ranged from 11 months to 9 years with a mean of 48.61 ± 28.85 months and median of 39 months. Girls and boys did not differ significantly in age ($Z = 0.88$; $P = 0.38$). The mean age of girls was 51.21 ± 26.8 months (median 42 months, range 14–96 months), and the average age of boys 46 ± 31.29 months (median 33 months, range 11–108 months). Up to the age of 3, boys were the majority, while the girls in the 4–9 age group were the majority. Figure 2 shows the number of children, in particular age groups, depending on gender.

LDC exposure most often occurred from Friday to Sunday (21; 55.26%). In most cases (23; 60.53%), children were not supervised by caregivers when the incident occurred. The exposure factor was known in all analysed patients. Capsule type was given by parents of 17 patients (44.74%), that is, 11 children (64.71%) were exposed to the three-component capsule, while 6 children (35.29%) to the two-component capsule.

Ingestion was the most common route of LDC exposure, affecting 37 patients (97.37%). Among that group, nine patients (23.68%) also had skin with the broken capsule. In one patient (2.63%), exposure to LCD was only through eyes and skin.

Symptoms occurred in 27 patients (71.05%). The age of symptomatic children (mean 50.4 ± 30.1 months; median 48 months,

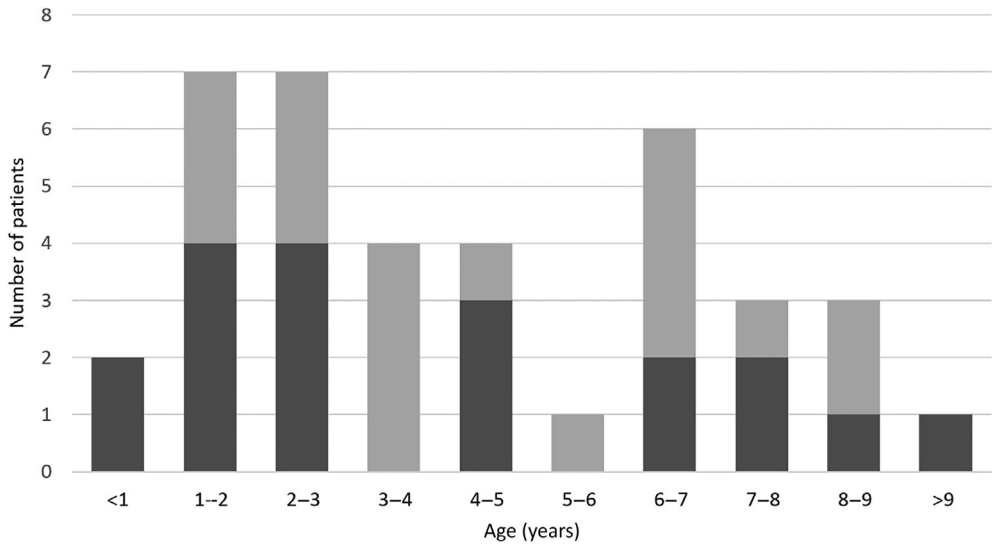

Fig. 2 Analysis of children from the study group in terms of gender, in particular age groups (■, girls; ■, boys).

Table 1 Characteristics of patients in whom gastroscopy was performed

No.	Gender	Age (months)	Symptoms in physical examination	X-ray result	Gastroscopy result
1	Female	36	Vomiting, nausea, cough, shortness of breath, drooling	Decrease in aeration in the upper left pulmonary field	Chemical burn of the oesophagus, Zargar grade IIIa
2	Male	52	Vomiting	Increased pulmonary–vascular pattern, bilateral peri-bronchial and perihilar inflammatory consolidations in the lung pattern	Chemical burn of stomach
3	Male	84	Drooling, changes in the oral cavity and throat	No signs	Chemical burn of oral cavity, chemical burn of the oesophagus, Zargar grade I, chemical burn of the stomach
4	Male	18	No symptoms	No signs	No signs
5	Female	22	Vomiting	Fine patchy perihilar bilateral peri-bronchial consolidations	No signs
6	Female	36	Vomiting, drooling, sore tongue/ throat	No signs	No signs
7	Female	21	No symptoms	No signs	No signs

range 11–108 months) did not differ significantly from the age of asymptomatic children (mean 44.3 ± 26.3 months; median 33 months, range 18–87 months) ($Z = 0.42$; $P = 0.68$).

The most commonly reported symptom after capsules ingestion was vomiting (23; 60.53%). Other symptoms included coughing (7; 18.42%), salivation (5; 13.16%), nausea (4; 10.53%), redness of the mouth (3; 7.89%), rash (3; 7.89%), shortness of breath (2; 5.26%), sore throat (2; 5.26%), redness of throat (1; 2.63%), drowsiness (1; 2.63%), abdominal pain (1; 2.63%) and breathing disorders (1; 2.63%).

Gastroscopy was performed in seven (18.42%) children. Abnormalities were identified in three children. Table 1 presents the characteristics of patients undergoing gastroscopy and the results of endoscopic examination. Gastroscopy was performed in 5 of 27 symptomatic children (18.5%) and in 2 of 11 asymptomatic patients (18.18%). There was no correlation between the occurrence of symptoms and the decision to perform gastroscopy ($\chi^2 = 0.0006$; $P = 0.98$). The age of children undergoing gastroscopy (mean 38.4 ± 23.3 months; median 36 months, range 18–84 months) did not differ significantly from the age of children who did not undergo gastroscopy (mean 50.9 ± 29.8 months; median 48 months, range 11–108 months) ($Z = 0.88$; $P = 0.38$).

Twenty-seven patients (71.05%) underwent chest X-ray out of which 11 (28.95%) revealed abnormalities including fine patchy bronchial consolidations (7; 63.63%), increased bronchopulmonary vascular pattern (5; 45.45%) and increased pulmonary vascularity (2; 18.18%).

Discussion

The incidence of exposures to LDC in children is not known. According to the National Poison Data System in the USA between 2012 and 2017, the annual exposure rate per 1 million children <6 years old varied from 263.1 in 2012 to 557.7 in 2015.[9] Depending on the age group, 0.9–1.4% of children required admission to critical care unit, while 1.3–2.2% to non-critical care unit.[9] In 2014, the International Association of Soaps, Detergents and Maintenance Products (A.I.S.E.) launched the 'Keep Caps from Kids' campaign aimed at preventing accidental exposure to capsules, especially among young children.[6] Despite this campaign, in our study, there seems to be an upward trend in hospitalisation due to LDC exposure. On the other hand, Singh *et al.* observed a decrease in the incidence of LDC exposure since 2014.[10] Settimi *et al.* noticed a significant decline in exposure to LDC (from 1.03 to 0.36 cases/day and from 1.88 to 0.86 cases/million units sold), which occurred 4 months after the introduction of opaque outer packaging in the major company producer of LDC in Italy.[11]

Our results are consistent with a research by Williams *et al.* who pointed out that 95.6% children were also below 5 years of age.[12] Yin *et al.* found that 90.3% episodes involved children aged ≤3 years.[13] The reason of this fact may be organoleptic exploration of the world and development of motor skills in this age group. An interesting shape, colour or smell make the child eager to reach for the capsule, perceiving it as a toy or food. Infants and toddlers exhibit interest of the surrounding world which is not always matched by their capability to understand potential environmental threats.

Our analysis, similar to the study by Settimi *et al.*,[11] showed that both boys and girls were exposed to capsules with the same frequency. On the other hand, girls dominated in the study by Yin *et al.*,[14] while boys predominated in the study by Singh *et al.*[10]

In our study group, only 44.74% of patients could accurately determine the capsule brand with which the child had contact. In the Williams *et al.*'s study, the capsule brand was determined in 93.4% of patients.[8] Manufacturers' websites, advertising material and packing rarely contain information on LDC composition. The legibility of labels containing information on LDC composition rarely identifies the pH and/or the presence of non-ionic surfactants, which contribute to toxicity.[6]

The most common route of LDC exposure in our group was ingestion. Ingesting capsule contents was the most common exposure route reported in several other studies.[11,12,14–16]

Most children exhibited mild symptoms of exposure to LDC which were commonly related to gastrointestinal tract.[12,14,17] However, one needs to be aware of symptoms from other organ systems including skin, eyes and respiratory tract.[8,11,16,18] Life-threatening symptoms after exposure to LDC, such as respiratory failure, seizures, central nervous system depression and even death, have been reported.[5]

In our study group, gastroscopy was performed in 18% of patients. Day *et al*. indicated that endoscopic examination should be performed in children who experience symptoms such as swallowing difficulties, drooling or burns of the mouth and throat area after the incident with the LDC.[16] In the study of Singh *et al*., it was found that endoscopic examination should be performed in patients who show abnormalities on physical examination for LDC exposure. The authors of this study stated that the presence of abnormalities in the physical examination of the oral cavity correlated with 80% probability of the presence of pathological changes in the gastrointestinal tract revealed during gastroscopy.[10] On the other hand, Smith *et al*. emphasised that the lack of changes in the physical examination does not exclude a chemical burn of the oesophagus after ingestion of the LDC contents, and the correlation between abnormalities in oropharyngeal examination, and findings in gastroscopy.[19] In our study, no relationship was found between the decision to perform gastroscopy, and the child's age and presentation of symptoms. However, these results should be interpreted with great caution due to the small number of patients analysed.

In our centre, most gastroscopies showed no or minor abnormalities. However, two patients had a chemical burn of the oesophagus, one of them had a chemical burn of grade IIIa in the Zargar classification. Yin *et al*. also noted that in the majority (96%) of endoscopic examinations, changes in the gastrointestinal tract were small or insignificant.[13] On the other hand, in the Vohra *et al*.'s study, abnormalities in the oesophagus and stomach were found in 59% of patients after exposure to capsules.[20] It seems that the decision to perform gastroscopy in a child after LDC exposure is made individually. Literature on LDC ingestion provides insufficient data to determine predictive factors of chemical injury of the gastrointestinal tract. Therefore, it is difficult to establish high-quality and reliable guidelines based on available studies.

Chest X-ray was performed in the majority of patients in the examined group; however, abnormalities were found in less than 30% of patients. Most of these abnormalities are not specific for LDC ingestion and can be attributed to intercurrent respiratory tract infection. In the study of Yin *et al*., all patients who underwent chest X-ray did not show any changes.[14]

It should be emphasised that our work may have some limitations due to its retrospective nature. To minimise the risk of omission of patients after LDC exposure, the medical records of patients with a wide range of underlying or concurrent diagnoses were initially analysed. In addition, some limitations of inference may result from the fact that the study analysed patients hospitalised only in one gastroenterological ward of a paediatric hospital. It should be noted that patients were admitted to our department primarily with suspected gastrointestinal effects after LDC exposure, which may also affect the results obtained.

Conclusions

In conclusion, children younger than 5 years of age are most often exposed to laundry capsules. Although most cases after LDC exposure were mild or moderate, ingestion of the contents of the capsules can lead to serious consequences such as severe chemical burns of the oesophagus. There are currently no guidelines or recommendations regarding the management of children after LDC exposure. Additional forms of packaging protection for LDC would also reduce the risk of children exposure. Another important element in packaging is to place a clear detergent composition with pH of the product. It also seems justified to conduct educational campaigns directed at parents and guardians of children aimed at raising awareness about the threat of LDC, especially among young children and people with intellectual disabilities.

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