

Transfer of chemicals to a secondary container, from the introduction of new labelling regulation to COVID-19 lockdown: A retrospective analysis of exposure calls to the Poison Control Centre of Rome, Italy, 2017–2020

Michele Stanislaw Milella^{1,2}  | Maria Caterina Grassi² | Alessia Gasbarri¹ | Valeria Mezzanotte¹ | Francesco Pugliese³ | Gabriella Vivino¹

¹Poison Control Centre Unit, Department of Emergency, Anesthesia and Critical Care Medicine, Policlinico Umberto I Hospital-Sapienza, University of Rome, Rome, Italy

²Department of Physiology and Pharmacology “V. Erspamer”, Sapienza University of Rome, Rome, Italy

³Department of Emergency, Anesthesia and Critical Care Medicine, Policlinico Umberto I Hospital-Sapienza, University of Rome, Rome, Italy

Correspondence

Michele Stanislaw Milella, Poison Control Centre Unit, Department of Emergency, Anesthesia and Critical Care Medicine, Policlinico Umberto I Hospital-Sapienza, University of Rome, Viale del Policlinico 155, 00161 Rome, Italy.
Email: m.milella@policlinicoumberto1.it

Abstract

The transfer of a chemical product from its original container to an unlabelled secondary container by consumers is a potential health hazard that may result in unintentional exposures and intoxications. The aim of this study was to describe the pattern of prevalence of exposures to transferred products in Italy from year 2017, when the new European labelling regulation for chemicals became fully operative, to 2020, year of the coronavirus 19 disease first outbreak. Calls to the Poison Control Centre (PCC) of Policlinico Umberto I Hospital - Sapienza University of Rome were analysed retrospectively for characteristics, clinical presentation and circumstances related to the event. We registered 198 cases of interest. There was a reduction in cases from 2017 (4.9%) to 2019 (2.2%), followed by an increased prevalence in 2020 (4.2%) mainly due to the months “post-lockdown.” The transferred product was very frequently diluted, and an empty drinking bottle was usually used as secondary container. Exposures were mostly of minor severity, and no deaths occurred. The study highlights the importance of PCCs data in the evaluation of the hazard communication to users through labels and advises for public campaigns to promote safe behaviours during future lockdowns to prevent exposures at a later period.

KEYWORDS

container label, COVID-19, lockdown, Poison Control Centre, transfer to secondary container

1 | INTRODUCTION

The European Chemical Agency (ECHA) requires for chemical products placed on the market to be appropriately labelled on the container.¹ The label must include

composition and hazards specific for the chemical and mixture, as well as precautionary statements to prevent adverse effects for both human health and the environment. The transfer to a secondary container (TSC), such as a drinking bottle, unlabelled or inappropriately

labelled, may cause the loss of this product information. While international agencies for occupational safety mandate to label each secondary container unless intended only for immediate use,^{2,3} the behaviour of private consumers is a matter of concern. In fact, TSC is a fairly common practice in the home environment,⁴ and a large retrospective analysis showed that unintentional exposures to transferred chemical products in the United States frequently result in Emergency Departments (ED) or hospital admission.⁵ The products more involved are not only household detergents and disinfectants but also hydrocarbons, solvents and pesticides.⁶

Poison Control Centre (PCC) management of exposures to products stored in unlabelled containers is challenging for two reasons: first, the identification of the chemical properties is hampered by the absence of a label; second, and as a consequence of the first point, risk assessment may not be accurately defined. It is clear that when relevant information is not readily available to the PCC personnel, it may lead to excessive health care utilization⁷ or inappropriate treatment. A possible way to discourage the practice of TSC is to create labels that convey the hazard information to the end consumer in a more effective manner.⁸ In this respect, we consider the practice of TSC a good proxy for the evaluation of the efficacy of the hazard communication to users.

By June 2015, the European Union legislation on classification, labelling and packaging (CLP) replaced the previous provisions of the Dangerous Substances Directive 67/548/EEC (DSD) and the Dangerous Preparations Directive 1999/45/EC (DPD) for EU suppliers of substances and mixtures.¹ The most noticeable differences introduced by the CLP are the use of a new hazard classification, with new health hazard classes and categories, new hazard pictograms, signal words, and hazard and precautionary statements.⁹ The new legislation entered into full force in June 2017, following a transitional phase with a derogation for mixtures already placed on the market before 2015. Whether the new legislation had any impact on the practice of TSC in terms of exposures and intoxications in the home setting in recent years has not been investigated yet.

The aim of this study was therefore to describe the prevalence and characteristics of calls regarding exposures to chemicals transferred to unlabelled containers received by the PCC of Policlinico Umberto I Hospital-Sapienza University of Rome, Italy, in the period between 2017 and 2020. Importantly, though, 2020 saw the advent in Europe of the coronavirus disease 19 (COVID-19) pandemic. Italy was the first European pandemic epicentre and also the first European country to impose a lockdown on the population. Stringent measures were in fact implemented to promote social distancing and constrain

spreading of COVID-19.¹⁰ We had previously shown that the lockdown had an impact on the type of calls received by the PCC, with an increase in exposures to household products such as hands and surface sanitizers.¹¹ In the present analysis, we thus assessed whether the lockdown also affected exposures to chemical products transferred to a secondary container.

2 | MATERIALS AND METHODS

Data of telephone calls were extracted from the database of the PCC and analysed retrospectively. Each telephone call was managed complying with the internal operating procedures and using a standard data collection form. The total number of first calls (follow-up calls excluded) received between 1 January 2017 and 31 December 2020 was 7986. As we previously reported, a sensible reduction in information calls during the 2020 “lockdown,”¹¹ calls for information requests were excluded, leaving 6269 calls regarding actual exposures and intoxications for the analysis. A case involving a TSC was defined as an unintentional exposure to a chemical product either (i) transferred to an unlabelled or mislabelled secondary container (diluted or not) or (ii) transferred and stored in an unlabelled container following the recommended dilution. Cases of exposures to products transferred and diluted per recommendation but not stored after use were excluded. We also excluded cases in which the exposure occurred during the act of transferring. All cases of interest when entered in the database were coded as “administration error” (routinely intended for medications only) to be easily retrieved when necessary.

The primary objective was to describe the main characteristics of cases involving a TSC and the prevalence rate across the years. The poison severity score¹² was used to grade severity of cases as follows: none (grade 0), no symptoms or signs related to poisoning; minor (grade 1), mild, transient, and spontaneously resolving symptoms; moderate (grade 2), pronounced or prolonged symptoms; severe (grade 3): severe or life-threatening symptoms; fatal (grade 4), death.

The secondary objective was to evaluate the prevalence of cases of interest in the “lockdown” period of 2020 (9th of March to 15th of June) compared with the same period in the previous 3 years.

The archived paper file of each case was retrieved and a second medical toxicologist reviewed the data for consistency and for errors in categorization. The interrater reliability score, assessed with the Cohen’s kappa statistic, was 0.80 for the variables considered.

Comparative statistical analysis was performed using Pearson chi-square tests for categorical variables. When

significant ($p < 0.05$), z tests on relative proportions (percentage of total) with Bonferroni correction were conducted as post-hoc tests. IBM SPSS Statistics version 25 was used for the data analysis. Ninety-five per cent confidence intervals (CI) for proportions were calculated with the Clopper–Pearson method.

This study was determined to be exempt from review by the Institutional Review Board at our institution.

The PCC of Policlinico Umberto I Hospital-Sapienza University of Rome mainly operates at the regional level, with about 70% of calls received from the city of Rome and the Lazio region. The catchment area includes approximately 6 million people, and is also covered by two other independent PCCs located in Rome that operate concurrently. Penetrance of this PCC is on average 0.4/1000 residents per year. In 2016, the PCC was reorganized to return fully operative 24 h by 2017. This positively affected call volume that increased in the following 2 years before the COVID-19 pandemic.

3 | RESULTS

Between 2017 and 2020, the PCC registered a total of 198 cases of exposure/intoxication to chemical products transferred to a secondary container. The absolute number of cases per year decreased since 2017: 63 in 2017, 53 in 2018, 38 in 2019 and 44 in 2020. The rate of cases per year also decreased from 2017 (4.9%) to 2019 (2018: 2.4%; 2019: 2.2%), but significantly increased again in 2020 (4.2%) ($\chi^2(3) = 25.98$, $p < 0.001$) (Table 1). In general, household and cleaning products were the most involved (Table 2). The chemical compounds mostly represented, either alone or in mixtures, were sodium hypochlorite ($n = 42$, 21.3%), cationic surfactants ($n = 27$, 13.6%), anionic surfactants ($n = 21$, 10.6%), hydrocarbons ($n = 14$, 7.1%), ethanol and other alcohols ($n = 17$ e 9.0%), hydrogen peroxide ($n = 8$, 4.0%), ammonium hydroxide ($n = 7$, 3.5%), and sodium hydroxide ($n = 7$, 3.5%).

Where these data were available, the secondary container most involved was a drinking bottle, made of

either plastic or glass, and in most cases the product was also diluted (Table 2). Among diluted products, sodium hypochlorite-based products were the most frequent (15.8%). About 94% of all cases had none or only mild severity (Table 3). No severe cases or deaths were reported. The vast majority of cases required no intervention or only home monitoring (clinical observation if already at the hospital). There were no significant differences between private calls and calls from hospital/ER across all the variables considered. In 6.6% of cases, the PCC suggested referral to the ED; only 2.0% had to be admitted to a noncritical care unit following access to the ED. Eight out of the 11 cases (72.7%) judged of moderate severity involved a caustic household product. With respect to diluted TSC, nondiluted TSC were less likely to present with “none” severity (22.7% vs. 50.0; $\chi^2(2) = 7.48$, $p = 0.024$) and more likely to require a management intervention (81.8% vs. 57.9; $\chi^2(1) = 4.20$, $p = 0.040$).

During the COVID-19 “lockdown” period in Italy (from March to June 2020), the absolute number of cases involving a TSC did not increase compared with the same period in the previous years: 14 cases versus 29 in 2017, 27 in 2018 and 17 in 2019, confirming the decreasing trend over the years. The rate of cases in this specific period also significantly decreased and stabilized through the years ($\chi^2(3) = 16.97$, $p = 0.001$) (Figure 1). In sharp contrast, the rate of cases in the remaining half of the year (from July to December “post-lockdown”) significantly increased in 2020 ($\chi^2(3) = 23.96$, $p < 0.001$) compared with the same period in the previous three years: 7.0% (95% CI 4.3–10.5%) vs. 3.9% in 2017 (95% CI 2.6–5.6%), 1.9% in 2018 (95% CI 1.2–2.9%), and 2.3% in 2019 (95% CI 1.3–3.5%) (Figure 1). There were no differences in the age group distribution of cases or in the frequency of the product category involved across the years in both periods considered.

4 | DISCUSSION

There were three main findings from our study. First, the rate of cases of exposure to chemical products transferred

TABLE 1 Total number of calls regarding exposures (including intoxications) received by the Poison Control Centre and number and rate of cases involving chemical products transferred to a secondary container

	Year			
	2017	2018	2019	2020
Total calls, n	1288	2175	1763	1043
Cases involving a TSC ^a , n (%) 95 CI %	63 (4.9)e 3.8–6.2	53 (2.4) 1.9–3.2	38 (2.2) 1.6–3.0	44 (4.2)e 3.1–5.6

^aTransfer to secondary container.

^e z test with Bonferroni correction ($p < 0.05$).

TABLE 2 Characteristics of cases of exposure to chemical products transferred to a secondary container registered by the Poison Control Centre

	Total n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)
Gender female	107 (54.0)	35 (55.6)	25 (47.2)	23 (60.5)	24 (64.5)
Age, mean \pm SD	43.3 \pm 23.1	41.4 \pm 25.5	42.9 \pm 23.1	42.3 \pm 19.1	47.7 \pm 22.5
Age group					
≤6	20 (10.1)	10 (16.4)	6 (11.3)	1 (2.8)	3 (7.3)
7–18	15 (7.6)	6 (9.8)	4 (7.5)	3 (8.3)	2 (4.9)
≥19	156 (78.8)	45 (73.8)	43 (81.2)	32 (88.9)	36 (87.8)
Caller site					
Private citizen	127 (64.1)	39 (61.9)	30 (56.6)	25 (65.8)	33 (75.0)
Hospital and ED	71 (35.9)	24 (38.1)	23 (43.4)	13 (34.2)	11 (25.0)
Site of exposure					
Home	188 (95.0)	60 (95.2)	52 (98.3)	35 (92.1)	41 (93.2)
Workplace	5 (2.5)	2 (3.2)	0	2 (5.3)	1 (2.3)
Other	5 (2.5)	1 (1.6)	1 (1.7)	1 (2.6)	2 (4.5)
Route of exposure					
Ingestion	180 (90.9)	60 (95.2)	46 (86.8)	33 (86.8)	41 (93.2)
Oral mucosa	16 (8.1)	3 (4.8)	5 (9.4)	5 (13.2)	3 (6.8)
Other	2 (1.0)	0	2 (3.8)	0	0
Secondary container used					
Bottle for water	36 (18.2)	18 (28.6)	8 (15.1)	3 (7.9)	7 (15.9)
Glass and cup	19 (9.6)	7 (11.1)	8 (15.1)	3 (7.9)	1 (2.3)
Other	5 (2.5)	3 (4.7)	0	0	2 (4.5)
Unknown	138 (69.7)	35 (55.6)	37 (69.8)	32 (84.2)	34 (77.3)
Dilution					
Diluted	76 (38.4)	23 (36.5)	22 (41.5)	18 (47.4)	13 (29.5)
Nondiluted	22 (11.1)	12 (19.0)	5 (9.4)	2 (5.2)	3 (6.8)
Unknown	100 (50.5)	28 (44.5)	26 (49.1)	18 (47.4)	28 (63.7)
Product category					
Household and cleaning products	146 (73.7)	45 (71.4)	39 (73.6)	29 (76.3)	33 (75.0)
Solvents and fuels	29 (14.7)	10 (15.9)	9 (17.0)	4 (10.5)	6 (13.6)
Pesticides and fertilizers	17 (8.6)	5 (7.9)	4 (7.5)	3 (7.9)	5 (11.4)
Other	6 (3.0)	3 (4.8)	1 (1.9)	2 (5.3)	0

to secondary containers and reported to the PCC decreased over the years from 2017 to 2019; second, the rate of cases increased again in 2020, but this was due to a higher prevalence during the COVID-19 “post-lockdown” period than during the “lockdown” months; third, most cases regarded household products, had none or only minor severity, although a small percentage still required access to a health care facility.

There is a paucity of data specifically investigating exposures to chemicals, including household and cleaning products, transferred from the original to a secondary container. Although the clinical toxicology

literature is aware of the potential hazards of the practice,^{5,13–15} there are currently no reports that have detailed the phenomenon in Europe and over a long period of interest. In rural Asia and other regions of the developing world, the health burden caused by improper storage of chemicals, pesticides and hydrocarbons in particular, is of major relevance especially for children.^{16–18} The PCC data show that the TSC is responsible of a fairly large proportion of calls concerning exposures to products or intoxications in the Lazio region, Italy. In fact, the mean prevalence across the years 2017–2020 was 3.2%, which is remarkably higher than what recently reported

TABLE 3 Clinical presentation of cases of exposure to chemical products transferred to a secondary container and management by the Poison Control Centre

	n (%)
No symptoms	84 (42.4)
Symptoms/signs (cases with) ^a	114 (57.6)
Pyrosis	42 (36.8)
Pharyngodynia	20 (17.5)
Epigastric pain	17 (14.9)
Nausea and vomit	15 (13.1)
Oral irritation	10 (8.8)
Hypersalivation	7 (6.1)
Oropharyngeal lesions	5 (4.4)
Agitation/anxiety	4 (3.5)
Abdominal pain	3 (2.6)
Cutaneous lesions	3 (2.6)
Dry mouth	2 (1.7)
Hematemesis	1 (0.8)
Diarrhoea	1 (0.8)
Lips swelling	1 (0.8)
Conjunctival hyperaemia	1 (0.8)
Tachicardia	1 (0.8)
Severity of case	
None	84 (42.4)
Minor	103 (52.0)
Moderate	11 (5.6)
Severe and death	0
Case management by PCC ^b	
None	59 (29.8)
Home monitoring or clinical observation ^c	101 (51.0)
Admitted to ED ^d	13 (6.6)
Referral to a specialist ^e	4 (2.0)
Admitted to noncritical care unit	4 (2.0)
Other	17 (8.6)

^aPatients may have had more than one symptom/sign at the same time.

^bFinal disposition by the Poison Control Centre.

^c“Home monitoring” may be suggested for private calls, “clinical observation” for hospital and emergency departments calls.

^dED = Emergency department.

^eMay be suggested for (i) private cases requiring a delayed specialist consultation or (ii) cases already admitted to hospital and emergency departments prior to Poison Control Centre consultation that require additional specialist evaluation.

on the USA National Poison Control data (0.25% at the peak).⁵ This could be in part explained by the inclusion of all calls in their prevalence analysis, whereas we considered exposure calls only. Nevertheless, other factors

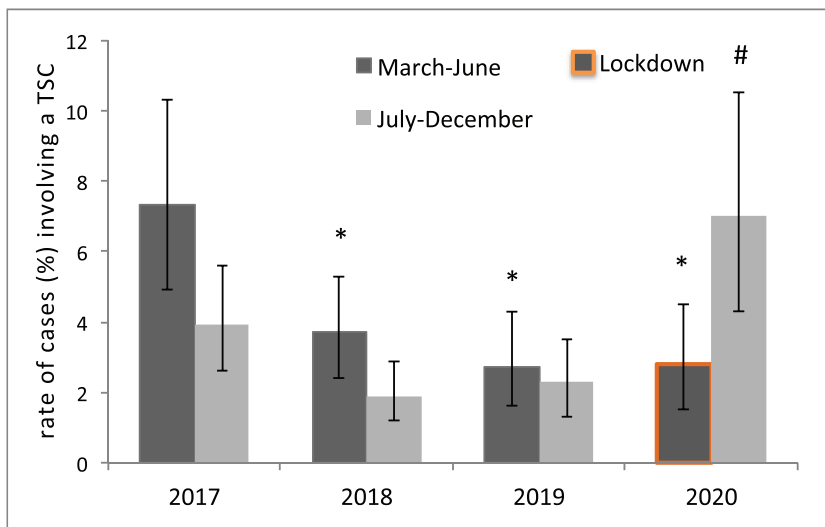
may account for the large discrepancy: the lower penetration of our PCC may reflect a different public utilization of the service, where cases considered more worth of attention access directly the ED with no prior home contact with the PCC. Regional variations and socio-demographic factors can also impact the utilization of the PCC.¹⁹

Notably, the prevalence of cases of exposures to products transferred to a secondary container showed a 50% decrease from year 2017 to 2018 and 2019. This reduction was not correlated to a change in the characteristics of the exposure (frequency of products involved, age group involved, or route of exposure). It is tempting to associate these results with the introduction of the new legislation for the labelling of containers by the ECHA, as it was applied to all chemical mixtures on the market by 2017. One important change involved the hazard pictograms, now replaced by new, graphically updated, symbols, with signal words “danger” or “warning” introduced based on the category of hazard. The visual elements are generally preferred by costumers over written messages, although direct and concise signal words usually add to the effectiveness of the message.²⁰ It is still unknown, though, whether the new pictograms have ameliorated the hazard communication to users; in a 2018 European survey, most consumers in Italy reported to be unfamiliar with the “health hazard” pictogram and only about 7% knew the meaning of the “corrosive” one.²¹ Therefore, at this point, any association between the reduction in cases involving a TSC and the newly introduced legislation on labelling remains purely speculative.

It is relevant to note that the CLP guidance does not require the labels of chemicals and mixtures to use the prevention precautionary statement P234 “Keep only in original packaging”: depending on the hazard class, it is in fact either suggested as highly recommended or recommended and in the selection process might be left out in favour of other statements. Since 2004 though, the international association for soaps, detergents and maintenance products AISE has proposed a set of “safe use” icons to improve the message to consumers of household products in the European community.²² The set includes the “do not change container to store items” icon. Major industry companies have been using these icons to complement the CLP labelling elements and guide towards safer behaviours. Again, the benefits of the “safe use” icons addition to the label on users hazard perception and behaviour are as yet unclear.²³

Another main finding in the present study is the reincrease in the prevalence of exposures to chemicals transferred to a secondary container in 2020 compared with the previous 2 years. This was expected, as the COVID-19 outbreak and relative “lockdown” measures

FIGURE 1 Rate of exposure cases per year involving a chemical product that was transferred from the original to a secondary container. Each year is split in two periods, from March to June, and from July to December. The period from March 2020 to June 2020 corresponds to the “lockdown” period during the COVID-19 epidemic in Italy. Bars represent 95% confidence intervals for proportions. *Significant z test with Bonferroni correction ($p < 0.05$) for relative proportions compared with March–June 2017; #significant z test with Bonferroni correction ($p < 0.05$) for relative proportions compared with July–December 2018 and 2019



enforced in 2020 have been associated with a surge in exposures to household products, in particular disinfectants and hands and surfaces sanitizers.^{11,24–26} In contrast to our expectations, however, the increase in cases involving a TSC did not occur during the “lockdown” months between March and June 2020, but in the “post-lockdown” months of the remaining part of the year. The prevalence rate in this time frame was in fact about three-fold higher than in the same period of 2018 and 2019. One possible explanation is that the practice of transferring products from the original container could have increased during the “lockdown” months when media were heavily promoting personal and home hygiene, and for practical reasons (higher frequency of use, multiple sites of use, emergency supply of maxi-size products) was considered an acceptable hazard to transfer/refill the products in different and smaller containers. It should be noted that the initial short supply of chlorine and alcohol-based products could have played a role in the phenomenon. The unlabelled containers could have been subsequently stored at a time when COVID-19-related risk was waning, causing the unintentional exposures and intoxications in the months of “post-lockdown.” In a similar fashion, this finding could perhaps in part also reflect a trend for homemade disinfectant preparations, which were published online during the first wave of the pandemic. This practice was, however, discouraged early by the Italian Health Department and our data do not directly assess this hypothesis.

In the present study, we have also explored for the first time some of the circumstances surrounding this type of exposures. In many cases, the secondary container used was a plastic drinking bottle originally intended for water, possibly because of its large availability in the domestic environment. The food container erroneously

assured the user of the safety of its content. Also, in most cases, the product was diluted in water. The dilution could explain the low rate of moderate or severe cases in our sample. This is consistent with the study by Carpenter and colleagues,⁵ where no data on dilution were reported. It will be important to consistently collect these variables in similar future studies by PCCs.

There are some limitations to this study. The data presented here reflect the activity of a PCC at the regional level in Italy and may not be representative of the Italian national picture. Also, given the small sample size, the findings might be an underrepresentation of the actual situation in the community. Moreover, it must be specified that all the information collected through phone calls is provided by the public or health care professionals and therefore its accuracy cannot be directly verified.

In summary, we have described the pattern of prevalence of exposure cases involving a TSC between years 2017 and 2020. There was a reduction in cases from 2017 to 2019, followed by an increased prevalence in 2020 during the months of “post-lockdown,” when the strict containment measures were gradually released towards the end of the first pandemic wave in Italy.

The results suggest the following considerations: first, although an understudied phenomenon, exposures to products transferred from the original container are very common especially in the home environment; second, European health agencies should rely on PCC data to evaluate the effectiveness of the hazard communication on labels, providing insight into the background of the exposure event; third, information campaigns could be enacted to educate consumer behaviour during future lockdown periods and prevent subsequent exposures to transferred chemicals; fourthly, icons and precautionary statements that advise against the transfer to a secondary

unlabelled container should perhaps be considered key elements to direct consumers towards a safer behaviour.

CONFLICT OF INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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DATA AVAILABILITY STATEMENT

Data are available upon reasonable request to the corresponding author.

ORCID

Michele Stanislav Milella  <https://orcid.org/0000-0002-5939-8549>

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