REUE | Original Article

Patterns of acute chemical poisoning cases registered with the Spanish Toxicovigilance System between 2015 and 2019

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BACKGROUND AND OBJECTIVE. The epidemiology of acute poisoning cases can shed light on how these events change over time so that preventive measures can be proposed. This study aimed to describe the characteristics of chemical poisonings treated in emergency rooms cooperating with the Spanish Toxicovigilance System (SETv).

MATERIAL AND METHODS. Descriptive observational study of poisonings due to chemical products found in homes, workplaces, or industrial plants that were registered with the SETv in the 5 years from 2015 through 2019 after treatment in 22 hospitals in 9 Spanish autonomous communities. We analyzed data for variables in the following categories: demographic (age, sex), cause (suicide; homicide; or exposure in the home, workplace or other setting), poison (toxic, irritant, or other gases; detergents; solvents; cosmetics; pesticides; caustic substances; metals; and other), route of exposure (mouth, respiratory system, skin, eye), initial symptom (neurologic, dermatologic, respiratory, cardiovascular, digestive, kidney, other), severity, and clinical course (hospitalization, discharge, death).

RESULTS. A total of 5709 cases were registered; 47.3% of the patients were women. The mean (SD) patient age was 38.05 (23.54) years. Accidental exposure in the home accounted for 77.2% of the cases. Workplace exposures and suicides were significantly more frequent in men ($P < .001$). Toxic gases were implicated in 44.2% of the cases; the next most frequent categories were caustic substances (18%), irritant gases (11.7%), and detergents (7.4%). The most common route of exposure was the respiratory tract (in 45.6%), and the most frequent symptoms involved the nervous system (24.1%). Patients presented in serious condition in 6.8% of the cases, and 13.3% were hospitalized. Patients spent a mean of 0.75 (3.54) hours in the emergency department. Mortality was 0.93%, and 85.3% of patients could be discharged home.

CONCLUSION. Chemical poisoning occurs mainly in the home. Most cases are unintentional, and the culprit substance is usually a toxic gas.

Keywords: Toxicovigilance. Poisoning. Chemical products. Public health.

Evolución de las intoxicaciones agudas por productos químicos en el quinquenio 2015-2019, registradas por el Sistema Español de Toxicovigilancia (SETv)

INTRODUCCIÓN. La epidemiología de las intoxicaciones agudas (IA), permite conocer su evolución y proponer medidas preventivas. El objetivo de este trabajo es describir el perfil de las IA por productos químicos atendidos en un grupo de servicios de urgencias españoles pertenecientes al Sistema Español de Toxicovigilancia (SETv).

MATERIAL Y MÉTODO. Estudio descriptivo observacional de IA por productos químicos de tipo doméstico, laboral o industrial registrados en el SETv, durante el quinquenio 2015-2019, en 22 hospitales, de 9 Comunidades Autónomas españolas. Se analizaron variables demográficas (edad, sexo), causa de la intoxicación (suicida, homicida, doméstica, laboral, otros), tóxico (gases tóxicos, gases irritantes, otros gases, detergentes, disolventes, cosméticos, plaguicidas, cáusticos, metales y otros), vía de entrada (oral, respiratoria, dérmica, ocular), sintomatología inicial (neurológica, cutánea, respiratoria, cardiovascular, digestiva, renal, otra), gravedad, y evolución clínica (ingreso, alta, fallecimiento).

RESULTADOS. Se registraron 5.709 casos, con una edad media de 38,05 ± 23,54 años y 47,3% de mujeres. El 77,2% de las intoxicaciones fueron de tipo accidental-doméstico. Las intoxicaciones laborales y las de intencionalidad suicida fueron significativamente más frecuentes en hombres (p=0,00). El grupo tóxico más frecuente fueron los gases tóxicos (44,2%), cáusticos (18%), gases irritantes (11,7%) y detergentes (7,4%). La principal vía de entrada fue respiratoria (45,6%), y los síntomas predominantes los neurológicos (24,1%). Se consideraron inicialmente graves el 6,8% de los pacientes. Ingresaron el 13,3% de las IA. La estancia media en urgencias fue de 0,75 ± 3,54 horas. Fallecieron el 0,93% de los casos, y el 85,3% fue dado de alta desde Urgencias.

CONCLUSIONES. Las IA por productos químicos ocurren fundamentalmente en el ámbito doméstico, por causas de tipo accidental, y debidas mayoritariamente a gases tóxicos.

Palabras clave: Toxicovigilancia. Intoxicaciones. Productos químicos. Salud pública.

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Introduction

Preventive strategies in public health rely on understanding the epidemiology of health problems.[1] Among them are acute poisonings (AP), due to their consequences in terms of morbidity, mortality, and use of health resources. Among poisonings, those with suicidal intent have increased significantly, particularly among younger segments of the population, generating both social and health concern.[2]

In 1999, the Spanish Toxicovigilance System (SETv) was established — a voluntary reporting program of poisoning cases caused by chemical products treated in emergency departments (EDs) and intensive care units (ICUs) of several Spanish hospitals. This program is managed by the Spanish Foundation of Clinical Toxicology (FETOC) under an agreement with the Subdirectorate General for Environmental Health and Occupational Health of the Directorate-General of Public Health (Ministry of Health).[3]

The objective of this study was to describe the evolutionary, demographic, and clinical profile of poisonings recorded in the SETv during the five years following the first published analysis,[4] and prior to the COVID-19 pandemic, which altered the profile of health care services, general hospital emergencies,[5] and specifically acute poisonings.[6-8]

Material and methods

We conducted a descriptive observational study on cases of acute poisoning caused by domestic, occupational, or industrial chemical products recorded in the SETv during the 5-year period 2015–2019. The study included 22 second- and third-level hospitals from 10 Spanish Autonomous Communities (Aragón, Asturias, Castile and León, Canary Islands, Catalonia, Balearic Islands, Madrid, Navarre, Basque Country, and Valencia).

A case was defined as any patient discharged from the ED or admitted to hospital with a diagnosis of acute poisoning by chemical products. Chronic poisonings, foodborne toxinfections, and those caused by drugs, medications, or inert foreign body ingestion were excluded.

The following variables were recorded: demographic data (age, sex, and date), cause of poisoning (suicidal, homicidal, domestic, occupational, or other), type of toxic agent (toxic gases, irritant gases, other gases, detergents, solvents, cosmetics, pesticides, caustics, metals, and others), route of exposure (oral, respiratory, dermal, ocular), initial symptoms (neurological, cutaneous, respiratory, cardiovascular, digestive, renal, or other), severity of poisoning, treatment administered, hospital stay, sequelae, and discharge status (recovery, improvement, or death).[4]

Comparisons of proportions were performed using the chi-square or Fisher's exact tests. Comparisons between independent groups were analyzed with the Mann–Whitney test. A *P*-value < .05 was considered statistically significant. Statistical analysis was conducted using SPSS v.21.0.0 for Windows (IBM Corporation, USA).

Results

Demographic data

A total of 5,709 cases were recorded, with an annual average of 1,142 cases (SD, 86.48). Table 1 shows the annual incidence rate. The mean age was 38.05 years (SD, 23.54). Women accounted for 47.3% of the cases, and their mean age was significantly higher than that of men (38.96 ± 24.08 vs 37.16 ± 22.93, *P* = .004). There were no sex distribution differences over the study years (*P* = .31). Figure 1 illustrates the distribution of cases by day of the week and month, with no significant differences (*P* = .31). Figure 2 illustrates the geographical distribution of cases by province: Barcelona (40.1%) included 5 hospitals *(Clínic, Hospital del Mar, Sant Joan de Déu, Moisès Broggi,* and *Hospital de Sabadell);* Balearic Islands (11.6%) included the *Can Misses Hospital* (Ibiza) and *Son Espases* hospitals (Mallorca); Madrid (3.7%) included *La Paz* and *Puerta de Hierro* hospitals; and Valencia (1%) included *La Fe* and *Hospital General*.

Clinical characteristics

Most poisonings (77.2%) were accidental–domestic, followed by accidental occupational (10.6%) and suicidal (8.9%) (Table 2). Other etiologies accounted for < 1%. Occupational and suicidal poisonings were significantly more frequent in men than in women (*P* = .00).

The most frequent toxic agents involved were toxic gases (carbon monoxide and cyanide) (44.2%), followed by caustics (18%), irritant gases (chlorine, chloramine, ammonia) (11.7%), and detergents (7.4%) (Table 2). Patients poisoned by these most common agents were significantly older (*P* = .00).

The main route of exposure was respiratory (45.6%), although this variable was not recorded in 22.2% of cases. Symptoms were present in 48% of patients, but data were missing in 18.5% of cases. When symptoms were specifically asked about, 25.66% of patients were asymptomatic. The most common symptoms were neurological (24.1%), respiratory (20.3%), and digestive (19.2%), with no significant differences between them (Table 3).

Clinical course

Severe cases accounted for 6.8% of patients, and these were hospitalized more frequently than mild cases (34.6% vs 7.3%, *P* = .00). However, severity was not assessed in 58.7% of cases (Table 3). Overall, 13.3% of patients required hospital admission. Table 4 illustrates the

Table 1. Cases per year and demographic data

Year	Cases/year N (%)	Men N (%)	Women N (%)	Missing data	*P*
2015	1,117 (19.6)	564 (50.5)	542 (48.5)	11 (0.98)	.31
2016	1,105 (19.4)	591 (53.5)	493(44.6)	21 (1.9%)	
2017	1,277 (22.4)	641 (50.2)	618 (48.4)	18 (1.4)	
2018	1,046 (18.3)	521 (49.8)	510 (48.8)	15 (1.43)	
2019	1,164 (20.4)	611 (52.5)	540 (46.4)	13 (1.12)	
Total	5,709 (100)	2.928 (51.3)	2.703 (47.3)	78 (1.34)	

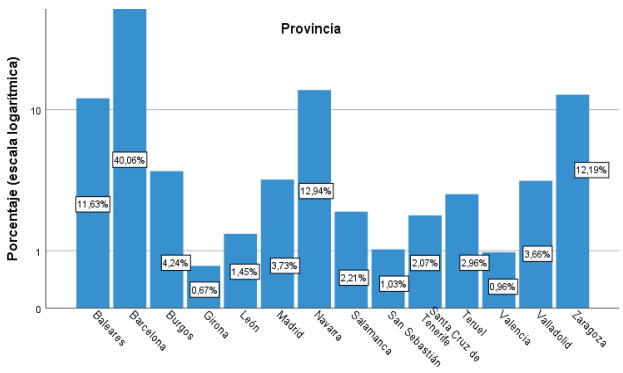

Figure 1. Cases by province.

severity, patient outcome, and care times according to the type of toxic agent involved. The mean length of the ED stay was 0.75 ± 3.54 hours; mean length of stay was 6.43 ± 10.65 days. The groups exposed to caustics and toxic gases showed the greatest clinical severity and the highest hospitalization rates (P = .00).

There were 53 deaths (0.93%). Of these, 58.5% (31 cases) had no initial severity level recorded. No patient classified as mild died. Recovery at discharge was recorded in 85.3% of cases, and clinical improvement in the remainder. Sequelae at discharge occurred in 2.35% (134 patients), with this variable recorded in 77% of cases. Table 5 lists the causes of death and sequelae. Nearly 47% of deaths were due to suicide or domestic accidents (36%).

Discussion

AP caused by chemical products continue to be a public health problem in Spain, as in other developed countries.[9,10] Moreover, compared with our group's former study (covering 1999–2014), the present series reports 1,142 annual cases versus 703 per year previously, even though the SETv includes fewer participating centersa nd a shorter recruitment period.[4]

In this series, the demographic profile remains similar, with a mean age of 38 years and a slight predominance of males, increasing from 50.7% up to 52.7%. Regarding the cause of poisoning, domestic cases increased by 10% (from 67.7% up to 77.2%), with toxic gases (89%) continuing to be the main cause, followed by exposure to irritant gases (73.7%).

The largest source of epidemiological information on acute poisonings is the Annual Report of the National Poison Data System (NPDS), which compiles data from calls made to U.S. poison control centers. The 2019 NPDS report analyzed a total of 2,148,141 human poisoning cases. Among the 5 most common substance categories causing AP, household cleaning products and cosmetics/hygiene products ranked 2nd and 3rd, with 7.13% and 6.16%, respectively. The group of "other chemical products" ranked 20th (1.82%), while toxic gases, fumes, and vapors ranked 23rd (1.46%). Nevertheless, in our study, this last group ranked 1st among all analyzed categories. When the NPDS reviewed the cumulative data for products responsible for APs over the last decade, toxic gases ranked 15th (95% CI, 31–103).[9]

No significant differences were found in the distribution of cases by day of the week, which is consistent with our former study. However, Sunday remained the day with the highest number of cases, a finding with no clear explanation, which should be monitored in future studies, as has been noted for other types of poisonings.[11] Similarly, although no statistical significance was found, colder months showed a 10% higher incidence rate, coinciding with the increased use of boilers and heaters, which raise the risk of carbon monoxide exposure.

Most suicidal poisonings were caused by caustic substances and pesticides, 2 groups where preventive measures should continue to be strengthened. Furthermore, suicidal intent was associated with the youngest average age in the series (16.17 ± 14 years), which is consistent with findings from other studies and official statistics showing a worrisome increase in self-harm behaviors among adolescents. In fact, completed suicides among adolescents aged 10–14 years in Spain have increased by 134%.[2]

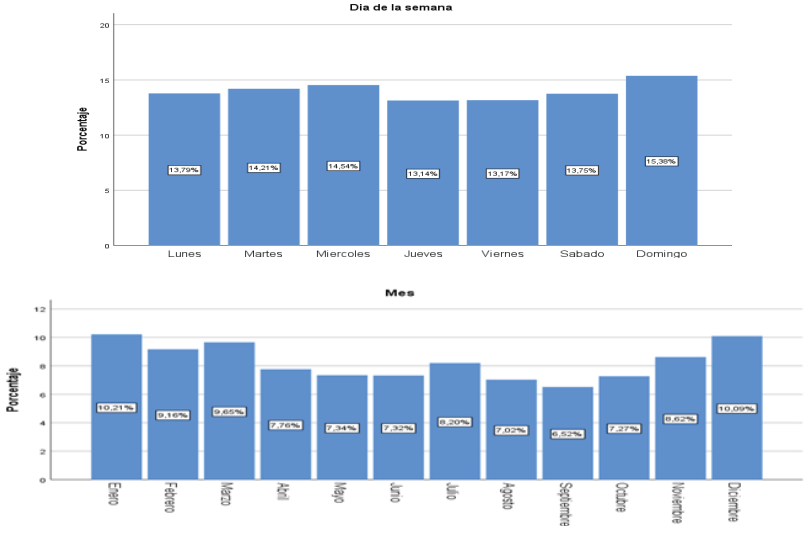

Figure 2. Cases by day of the week (A) and by month (B).

Table 2. Type of poisoning, type of toxic agent, and demographic and clinical characteristics

Type of poisoning	Total N(%)	Demographic data		Type of toxic agent									
		Mean age ± SD	Women N (%)	Caustics N (%)	Cosmetics N (%)	Solvents N (%)	Disolventes N (%)	Irritant gases N (%)	Toxic gases N (%)	Metals N (%)	Others N (%)	Other gases N (%)	Pesticides N (%)	*P*
Assault	3 (0.1)	22.67 ± 7.5	0 (0)	0	0	0	0	3 (0.4)	0	0	0	0	0	
Food-related	5 (0.1)	40.4 ± 28.33	3 (60)	0	0	0	0	0	0	2 (7.1)	3 (1.5)	0	0	
Unknown	44 (0.8)	41.45 ± 17.05	13 (29.5)	9 (0.9)	0	0	6 (1.3)	7 (1)	14 (0.6)	0	2 (1.0)	2 (6.3)	4 (1.4)	
Domestic	4,406 (77.2)	37.06 ± 25.09	2,246 (50.9)	653 (63.5)	53 (81.5)	358 (85.0)	271 (59.2)	493 (73.7)	2241 (88.8)	16 (57.1)	153 (77.3)	11 (34.4)	157 (55.7)	
Homicidal	29 (0.5)	33.66 ± 11.72	9 (31)	2 (0.2)	0	0	5 (1.1)	16 (2.4)	3 (0.1)	0	2 (1.0)	0	1 (0.4)	
Iatrogenic	10 (0.2)	59.4 ± 14.02	5 (50)	2 (0.2)	2 (3.1)	1 (0.2)	0	0	0	0	0	1 (3.1)	4 (1.4)	
Occupational	605 (10.6)	40.69 ± 11.73	175 (28.9)	87 (8.5)	1 (1.5)	31 (7.4)	99 (21.6)	119 (17.8)	198 (25.0)	7 (11.1)	22 (34.4)	11 (10.6)	30 (10.6)	.0
Overdose	39 (0.7)	30.56 ± 16.07	4 (23.5)	0	0	0	33 (7.2)	0	4 (0.2)	0	1 (0.5)	1 (3.1)	0	
Suicidal	506 (8.9)	16.17 ± 14.4	21 (52.5)	271 (26.4)	9 (13.8)	30 (7.1)	36 (7.9)	3 (0.4)	57 (2.3)	2 (7.1)	9 (4.5)	6 (18.8)	83 (29.4)	
Other	40 (0.7)	31.92 ± 16.21	10 (25.6)	1 (0.1)	0	1 (0.2)	1 (0.2)	27 (4.0)	4 (0.2)	1 (3.6)	4 (2.0)	0	1 (0.4)	
Not specified	17 (0.3)	45.57 ± 19.06	217 (42.7)	3 (0.3)	0	0	7 (1.5)	1 (0.1)	2 (0.2)	0	2 (1.0)	0	2 (0.7)	
Total	5,704 (100)	38.05 ± 23.54	2703 (47.3)	1,028 (18)	65 (1.1)	421 (7.4)	458 (8)	669 (11.7)	2523 (44.2)	28 (0.5)	198 (3.5)	32 (0.6)	282 (4.9)	
Mean age (SD)				38.63 ± 25.39	23.5 ± 26.7	28.46 ± 27.34	32.7 ± 22.27	41.69 ± 18.94	41.38 ± 21.82	34.13 ± 17.15	37.49 ± 25.11	23.86 ± 21.08	21.46 ± 23.65	.0
Women				510 (49.6)	38 (58.5)	225 (53.4)	158 (34.5)	408 (61)	1134 (44.9)	10 (31.3)	112 (39.7)	10 (35.7)	96 (48.5)	.0

Regarding the toxic agents involved, while the most frequent categories remain the same as in the previous study, toxic gases increased from 31% up to 44%, confirming the upward trend observed in 2013–2014. Irritant gases remained stable, whereas caustic agents and pesticides decreased. This decline may reflect improved handling and storage controls, but accidental exposures to toxic and irritant gases persist—likely due to poor accident prevention at home (eg, malfunctioning heaters, charcoal braziers, lack of ventilation), improper cleaning product mixing, and incorrect product use.

The percentage of patients requiring hospitalization decreased in this 2nd SETv series, from 20.6% to 13.3%. Likewise, the mean length of stay dropped from 32 down to 6 days. Although the proportion of patients achieving recovery or overall improvement dropped from 92.6% to 85.3%, a notable one-third reduction in mortality was observed (from 1.4% to 0.93%). This likely reflects better management of poisoned patients, as initially severe cases represented only around 7% of those treated in EDs.

Nevertheless, given that the overall mortality rate of AP in Spain ranges between 0.13%[12] and 0.5%,[13] and in some series is even 0% (though without complete follow-up data),[14] the chemical products analyzed in this study still represent a high morbidity and mortality risk. Therefore, the SETv remains a valuable public health tool.

A limitation of this study is the underreporting of some variables, with missing data ranging from 18% (initial symptom documentation) up to 59% (initial severity assessment). However, there was consistency between related data, such as severity level and hospital admission rate, supporting the reliability of the included cases.

Another limitation in epidemiological interpretation is that the study only includes poisonings reaching participating hospitals, excluding mild cases treated by emergency medical services, primary care emergency departments,[15] or occupational accidents managed by mutual insurance entities, as well as deaths occurring on-site, which are only recorded at the judiciary level.

In the 2019 NPDS, gas exposure in pediatric patients accounted for 5.41% of deaths in children younger than 5 years. Pediatric poisonings may also be underrepresented here due to the limited pediatric emergency coverage of participating hospitals.[16]

There is also a lack of unified criteria for coding some variables, such as poisoning severity, and possible underreporting due to emergency department workload. Nonetheless, after more than 20 years of SETv operation, its methodology is considered stable, and its data remain useful.

Conclusions

AP contribute to increased morbidity and mortality in the Spanish population. In conclusion, chemical poisonings occur mainly in the domestic setting, are typically accidental, and are most often due to toxic gases. Since 24% of signs and symptoms are neurological, physicians should consider possible poisoning as a cause of neurological al-

Table 3. Data on toxic exposure and initial patient assessment

Exposure			Initial presence of symptoms			Type of symptoms			Initial severity assessment		
Type	Frequency N (%)	Hospital admission N (%)	Type	Frequency N (%)	Hospital admission N (%)	Type	Frequency N (%)	Hospital admission N (%)	Type	N (%)	Hospital admission N (%)
Cutaneous	121 (2.73)	15 (0.34)	Not consigned	1,059 (18.5)	48 (18.3)	Cardiovascular	75 (1.31)	17 (0.30)	Not consigned	3,349 (58.7)	464 (58.1)
Ocular	307 (6.92)	11 (0.25)	No	1,908 (33.4)	57 (7.7)	Skin	137 (2.40)	21 (0.37)	Serious	387 (6.8)	134 (34.6)
Oral	1,408 (31.72)	303 (6.83)	Yes	2,472 (48)	550 (74)	Digestive	1,098 (19.23)	254 (4.45)	Mild	1,973 (34.6)	145 (7.3)
Respiratory	2,603 (58.64)	260 (5.86)				Neurological	1,374 (24.07)	177 (3.10)			
Total	4,439 (100)	589 (13.30)				Ocular	403 (7.06)	16 (0.28)			
						Respiratory	1,157 (20.27)	0			
						No symptoms	1,465 (25.66)	0			

Table 4. Poisoning severity, need for hospital admission, and care times by type of toxic agent

Type of toxic agent	Severity				Initial stay (N = 3,486)	Hospital admission				Length of sta (N = 260)
	Recorded data N (%)	Mild N (%)	Severe N (%)	*P*	Hours Mean (SD)	Recorded data N (%)	No N (%)	Yes N (%)	*P*	Days Mean (SD)
Caustics	394 (38.7)	334 (16.9)	60 (15.5)		1.87 (5.44)	1010 (98.2)	742 (15.3)	268 (36.1)		8.11 (14.23)
Cosmetics	22 (33.8)	22 (1.1)	0 (0)		0.17 (0.68)	0 (0)	60 (1.2)	5 (0.7)		0
Detergents	150 (35.6)	144 (7.3)	6 (1.6)		0.34 (2.36)	419 (98.2)	391 (8.1)	28 (3.8)		5.4 (10.01)
Solvents	164 (35.8)	140 (7.1)	24 (4.7)		1.18 (5.37)	454 (96.4)	371 (7.6)	83 (11.2)		5.83 (6.73)
Irritant gases	268 (40.1)	259 (13.1)	9 (2.3)		0.15 (1.53)	653 (97.6)	611 (12.6)	42 (5.7)		2.4 (2.06)
Toxic gases	1,102 (43.7)	839 (42.5)	263 (68)	.0	0.39 (2.12)	2,462 (97.6)	2,237 (46.1)	225 (30.8)	.0	4.41 (5.1)
Other gases	10 (31.2)	9 (0.5)	1 (0.3)		0.25 (0.55)	30 (98.2)	24 (0.5)	6 (0.8)		2 (1.41)
Pesticides	131 (46.5)	111 (5.6)	20 (5.2)		2.13 (6.23)	278 (96.4)	211 (4.3)	67 (9)		6.96 (9.1)
Metals	16 (57.1)	16 (0.8)	0 (0)		0.33 (0.97)	27 (99.1)	23 (0.5)	4 (0.5)		5 (0)
Others	103 (52)	99 (5)	4 (1)		198 (3.5)	195 (97.2)	181 (3.7)	14 (1.9)		8.67 (11.23)
Total	2,357 (41.28)	1,963 (100)	387 (100)		0.75 (3.54)	5,597 (98)	4,854 (87)	743 (13)		6.43 (10.56)

Table 5. Death rate and sequelae at discharge

Type of poisoning/death			Type of toxic agent				
			Toxin/sequelae at discharge		Toxin/death		
	N (%)	P		N (%)	P	N (%)	P
Assault	0	.0	Caustics	57 (42)	.0	23 (44)	.0
Food-related	0		Cosmetics	0		0	
Unknown	1 (2)		Detergents	8 (6)		5 (9)	
Domestic	19 (36)		Solvents	16 (12)		4 (8)	
Homicidal	0		Irritant gases	5 (4)		1 (2)	
Iatrogenic	1 (2)		Toxic gases	31 (23)		14 (26)	
Occupational	5 (9)		Metals	0		0	
NS/NC (Not specified)	0		Others	6 (5)		1 (2)	
Other	1 (2)		Other gases	1 (0.7)		0	
Overdose	1 (2)		Pesticides	10 (7.3)		5 (9)	
Suicidal	25 (47)						
Total	53		Total	134		53	

terations during initial assessment. More than one-third of affected patients were initially considered severe, highlighting the need for greater specialized training in toxicology among health care personnel.

The impact of the COVID-19 lockdown period and its subsequent consequences remains to be analyzed — an objective for the next SETv study (2020–2024).[17,18] All published unicentric and subgroup studies indicate substantial changes in incidence, rate epidemiological and clinical characteristics, or morbidity and mortality.[6,19-21] Therefore, this study serves as the baseline comparator for these expected (and concerning) trends[22].

ARTICLE INFORMATION

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