AN EMERGENCY DEPARTMENT-BASED EPIDEMIOLOGICAL VIGILANCE STUDY OF CHEMICAL-RELATED INTOXICATIONS


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Introduction

By virtue of the agreement signed between the Ministry of Health and Consumer Affairs, through the Subdirectorat General for Environmental and Occupational Health of the Directorate General for Public Health and Consumer Affairs, and the Clinical Toxicology Division of the Spanish Toxicology Association, whereby all cases of intoxication due to household, agricultural or industrial chemicals treated in Casualty Departments are to be reported, in accordance with Article 26.2 of Royal Decree (RD) 363/95 of June 5th and Article 12.3 of RD 1078/93 of July 2nd, and in agreement with the responsibilities set out in said agreement, the report corresponding to cases treated during 2003 is attached.

Results for 2003

A total of 603 cases from the 14 hospitals indicated in Figure 1 were treated during 2003.

Figure 1: PARTICIPATING HOSPITALS

![Bar Chart showing the number of cases treated at each hospital in 2003. The hospitals are: Donostia, San Pablo Barcelona, San Jorge Huesca, Universitario Salamanca, La Fe Valencia, General Valencia, Son Dureta (Baleares), Zumárraga (Guipuzcoa), Navarra, Miguel Servet Zaragoza, Universitario Canarias, Clínico Zaragoza, Ntra Sra Meritxell (Andorra), and Clínico Barcelona. The number of cases range from 0 to 150 for each hospital.]
The majority of cases were treated in the Casualty Departments, although 168 patients (28%) had to be admitted. The patients’ mean age was 38.59±22.53 years. As regards distribution by sex, 312 patients (52%) were male and 291 (48%) female (Figures 2 and 3).

**Figure 2: DISTRIBUTION BY AGE AND SEX (I)**

- Mean age: 38.59 years (SD 22.53)
  - min 11 days
  - max 100 years
- Men: Mean age 36.29 ± 21.72 years
- Women: Mean age 41.03 ± 23.15 years

**Figure 3: DISTRIBUTION BY AGE AND SEX(II)**

![Graph showing distribution by age and sex](image-url)
The cases were distributed relatively uniformly in terms of both day of the week and month of the year (Figures 4 and 5).

Figure 4: DISTRIBUTION BY DAY OF THE WEEK

![Bar chart showing distribution by day of the week]

Figure 5: DISTRIBUTION BY MONTH OF THE YEAR

![Bar chart showing distribution by month of the year]
As regards the etiological findings, domestic intoxications were by far the most common, accounting for 65% of all cases, followed by work-related intoxications (18%) and suicides (11%) (Figure 6).

Figure 6: TYPE OF INTOXICATION

The main groups of substances implicated were caustic household products, such as cleaning agents, followed by toxic gases, almost exclusively carbon monoxide generated in a domestic setting. A second group consisted of irritant gases, pesticides and solvents (Figure 7).

Figure 7: TYPE OF AGENT
Analysis of the characteristics of cases grouped by type of substance implicated showed that, as indicated above, the group of systemic toxic gases was mainly made up of cases of carbon monoxide intoxication (155 cases). The entry route for this group was respiratory. Neurological symptoms were the most common and the antidote was oxygen. The cases were split equally between both sexes, and the age coincided with the mean

Figure 8: TOXIC GASES

- 159 cases
  - Mean age ±22 años
  - Men 38±19
  - Women 37±24
- Route
  - Respiratory 159 casos
- Agent
  - CO 155
  - Other 4
The group concerning irritant gases (Figure 9) included 74 cases, which mainly involved the production of chlorine derivatives due to the mixing of household cleaning products such as bleach and hydrochloric acid or bleach and ammonia. The entry route was respiratory in the majority of cases, although two cases involved ocular entry. The symptoms were predominantly respiratory and treatment was symptomatic. Women were clearly the most commonly affected and intoxication occurred predominantly in the home, although a relatively large number of accidents occurred in the workplace. The age of patients intoxicated by these substances was somewhat higher than the mean, particularly for women.

Figure 9: IRRITANT GASES

- 74 cases
  - Mean age 40 ± 17 years
    - Men 39±15
    - Women 40±18

- Vía
  - Respiratory 72 cases
  - Ocular 2 cases

- Agent
  - Cl/Chloramine 50
  - Hydrochloric acid 17
  - Others 7
Caustic products were implicated in 166 cases (Figure 10), the majority of which involved household cleaning products, above all bleach. Much more dangerous products such as hydrochloric acid or sodium hydroxide were implicated in many fewer cases. The entry route was usually oral, although an important number of cases involved ocular entry. The symptoms were predominantly digestive or ocular, and treatment was symptomatic and decontamination. Once again, these intoxications mainly occurred in a domestic setting, and the number of attempted suicides was higher than the number of work-related accidents. The cases were evenly split between both sexes and the age was slightly higher than the mean.

**Figure 10: CAUSTIC AGENTS**

- **166 cases**
  - Mean age: 39 ± 22 years
    - Men 36 ± 23
    - Women 42 ± 21
- **Route**
  - Oral 112 cases
  - Dermal 4 cases
  - Ocular 51 cases
- **Agent**
  - Bleach 65
  - Ammonia 18
  - Sodium hydroxide 14
  - Hydrochloric ac 15
  - Acides 7
  - Unknown 22
Pesticides were reported to be implicated in 54 cases (Figure 11), which were fairly evenly distributed between the different families, although insecticides, particularly organophosphate-based products and pyrethroids, were the most common. The entry route was most commonly oral, followed by respiratory. The most common symptoms were digestive, neurological and respiratory and almost all groups of therapeutic procedures were followed, including a large number of antidote administrations, especially atropine. On this occasion suicides were most common, followed closely by work-related and domestic intoxications. Male patients were clearly the largest group and the age was much higher than the mean.

Figure 13: PESTICIDES

- 54 cases
  - Age 44 ± 20 años
    - Men 43 ± 21
    - Women 45 ± 19

- Route
  - Oral 31 cases
  - Respiratory 17 cases
  - Dermal 8 cases

- Agentes
  - OC insecticides 3
  - OF insecticides 15
  - Carbamates 7
  - Pyrethroids 9
  - Paraquat 4
  - Glyphosate 3
  - Rodenticides 2
  - Others 9
  - Unknown 9
There were 55 cases involving contact with various solvents (Figure 12), including 11 cases of alcohol intoxication (methanol and ethylene glycol). The main entry routes were oral and respiratory. The symptoms were primarily digestive and neurological and treatment was mainly symptomatic, although ethanol was used as an antidote in all cases of methanol and ethylene glycol intoxication. Domestic intoxications were by far the most common, followed at some distance by work-related intoxications and suicides. The age was lower than the mean and most cases involved men.

Figure 12: SOLVENTS

- 55 cases
  - Mean age 35 ± 20 years
    - Men 33 ± 18
    - Women 40 ± 24
- Route
  - Oral 30 cases
  - Respiratory 15 cases
  - Dermal 3 cases
  - Ocular 9 cases
- Agent
  - Methanol 4
  - Ethylene glycol 5
  - Toluene-xylene 2
  - Turpentine 2
  - Hydrocarbons 11
  - Others 15
  - Unknown 16

The group involving contact with detergents (Figure 13) had the lowest number of cases (39) and, as in previous years, various different household soaps and detergents and several different brands were implicated. The entry route was oral. Symptoms
were mild and mainly digestive and treatment was symptomatic and decontamination. As expected, the majority of incidents were domestic and affected mainly women. This is the first year in which a death was caused by this type of substance. This occurred in an elderly patient who suffered a bronchial aspiration.

Figure 13: DETERGENTS

- 39 cases
  - Mean age 42 ± 29 years
    - Men 35 ± 29
    - Women 50 ± 27
- Route
  - Oral 32 cases
  - Ocular 7 cases
- Agents
  - Household detergents
  - Various brands
It can be seen from Figures 14–19, which show the general situation for all cases, that the main entry route was respiratory, followed by oral. The main clinical symptoms, which were present in around 85% of cases, were digestive, neurological and respiratory, and symptomatic treatment was applied in 80% of cases, although an antidote was given in a large number of cases (167). The latter appear to be correctly indicated in most cases on the basis of the type of causal agent, as can be seen from Table 1, although there are insufficient clinical data to be able to confirm this type of indication.

Figure 14: ENTRY ROUTE

![Bar chart showing entry routes with respiratory being the most common followed by oral.]

Figure 15: CLINICAL SYMPTOMS

![Pie chart showing symptoms with digestive being the most common followed by neurological and respiratory.]
Figure 16: TYPE OF SYMPTOMS

Figure 17: TREATMENT
The evolution of the cases (Figure 20) highlights a similar degree of benignancy to that observed in previous years and confirms the identity of the most dangerous pesticides, caustic agents, solvents and toxic gases.
Figure 20: EVOLUTION

- Mean hospital stay 39 h
  - Max 45 days
  - Min 15 minutes

- Deaths 6 cases:
  - Toxic gases 1
  - Pesticides 4
  - Detergents 1

The mortality for this group of intoxications (1%) was lower in 2003 but still clearly higher than that for all the acute intoxications treated in our Casualty Departments, which was around 0.5% (Figure 21). The age of the patients who died was also clearly higher than the mean, and the majority were male. Four of these deaths were by suicide and the other two accidental, with pesticides being implicated in four cases (3 due to the herbicide paraquat), one case of CO inhalation and the other due to bronchial aspiration of detergent.

Figure 21: MORTALITY

- Total number of deaths: 6 (0.99%)
  - Age: 57 17
  - Type of intoxication
    - Suicide 4
    - Domestic 2
  - Agent implicated
    - Toxic gases 1 (CO)
    - Pesticides 4 (3 paraquat, 1 carbamate + methomyl)
    - Detergents 1
A COMPARATIVE SUMMARY OF THE FIRST FIVE YEARS OF THIS STUDY

A similar profile to those obtained in 1999–2002 was obtained in 2003. The most relevant comparison data for these five years, and the conclusions which can be reached from them, are presented below.

Table 3 shows the trend in terms of distribution by sex, age and location of the intoxication for all 2730 cases studied. The cases are split essentially evenly between the sexes, with a mean age of between 37 and 38 years, which is more than five years higher than for all the acute intoxications treated in the Casualty Departments.

Domestic intoxications remained stable at around 65% of the total, whilst work-related intoxications and suicides varied in the ranges 13–20% and 11–15%, respectively.

Table 4 shows the total number of cases and deaths for each of the product families chosen for study on the basis of being considered to involve a higher risk of producing an acute intoxication.

Their ranking in terms of number of cases is caustic agents, toxic gases, irritant gases, pesticides, solvents and detergents. The ranking in terms of mortality is pesticides, solvents, toxic gases, caustic agents and detergents. No deaths were caused by irritant gases.

The total number of cases covered by these families is 2503 (92% of the total) and the number of deaths 44 (100% of the total), thereby confirming the above assumption concerning their higher risk.

One substance stands out in each group in terms of its frequency or mortality. The four most important of these substances are listed in Table 5.

Carbon monoxide is by far the most important toxic gas. Its presence in a domestic setting is due to incomplete combustion or lack of ventilation in water heaters and central heating boilers, and also, on occasions, to house fires. This gas often produces family group intoxications. Its mortality is low but it is the most common agent, which is somewhat alarming given its potential toxicity.

The groups involving irritant gases and caustic agents have the same source, namely household cleaning products containing strong acids or bases, especially hydrochloric acid, ammonia, sodium hypochlorite and sodium hydroxide, which produce irritant gases upon incorrect mixing or produce intoxications upon contact or ingestion. The production of irritant gases such as chlorine or chloramine was a relatively common accident in this period, although relatively innocuous, and resulted in no deaths.
In contrast, the ingestion of hydrochloric acid, which is present in the home in several branded products and is labelled with the "irritant" pictogram, although relatively rare, has a mortality of 21%. The low mortality of the group of caustic agents in general is due, in most cases, to the fact that the product is ingested in a diluted form in water, which means that it loses some of its corrosive properties.

Of the solvents commonly present in a domestic setting, methanol, which is sold as burning alcohol or stain remover, stands out due to its risks, with a mortality of 16%.

The family with the highest mortality is that containing pesticides, amongst which the herbicide paraquat is the most significant due to its very high mortality of more than 60%.

It is very difficult to compare epidemiological data from different sources due to inherent source-related biases and different classification criteria. One of the most important sources for establishing human chemical agent exposure profiles is that compiled from the data bases belonging to the toxicological information centres’ telephone help lines. The largest of these is the Toxic Exposure Surveillance System (TESS, USA), which contains more than 34 million consultations concerning exposure to toxic agents since 1985 (1). One of the major limitations of these data bases, however, is the difficulty in separating asymptomatic exposures from actual intoxications. This results in a clearly different etiological profile, which is highlighted by the number of etiological situations and types of causal agent, with their corresponding effects on the popualional, clinical and prognosis characteristics, when this type of source is used versus casualty department-based studies. Thus, 51% of cases in the 2002 Annual TESS Report (2) were due to non-medicinal agents and 49% to medications. This is a major difference with respect to the cases treated in casualty departments (3), where non-medicinal agents represent only around 15% of the total. This difference is similar to that found for intentional intoxications: 80% of cases in TESS are accidental whereas this figure is only 25% for cases treated in Casualty (Table 6). A comparison between some of the mortality figures in TESS and in our report is provided in Table 7. The differences found for the mortality of the most dangerous agents are most probably due to the fact that the most serious cases are admitted directly to hospital and do not consult the information centres, which means that any assessment of the risk of acute human toxicity must necessarily also be based on data from hospital Casualty Departments.
Conclusions

1.- This type of study allows the profile of human chemical-related intoxications to be kept up to date.

2.- These products can be ranked in the five most important families: caustic agents, toxic gases, irritant gases, pesticides, solvents and detergents.

3.- The most dangerous agents in terms of frequency or mortality can also be identified: CO, methanol, paraquat and HCl.

As stated in the conclusions to the previous reports, we should therefore insist on the need to take preventative measures aimed at the domestic setting, particularly with regard to sources of CO exposure and the dangers of handling caustic household cleaning products that can release irritant gases. Likewise, attempts should be made to control the presence of the most dangerous chemical agents around humans, especially methanol in the home and paraquat in an agricultural environment.

References


### TABLE:

#### Tabla 1: Type of antidote and toxic agent

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<th>Nº</th>
<th>Antidote</th>
<th>Toxic agent</th>
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<tr>
<td>131</td>
<td>Oxígen (6 hiperbaric)</td>
<td>CO</td>
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<tr>
<td>8</td>
<td>Ethanol</td>
<td>Ethylenglycol 6 Methanol 2</td>
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<td>Fomepizol</td>
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<td>Atropine</td>
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<td>Pralidoxime</td>
<td>Insecticides organophosphates 5 Insecticides carbamates 3</td>
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<td>3</td>
<td>“Caribbean procedure”</td>
<td>Paraquat</td>
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#### Tabla 2: Caracteristics of lethal cases

<table>
<thead>
<tr>
<th>Nº</th>
<th>Sex</th>
<th>Age</th>
<th>Type</th>
<th>Agent</th>
<th>Route</th>
<th>Symptoms</th>
<th>Treatment</th>
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<td>Woman</td>
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#### Tabla 3: Caracteristics of global profile of cases (5 years)

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<td>15</td>
<td>13</td>
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<td>465</td>
<td>552</td>
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Table 4: Nº of cases and deaths by chemical family

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Table 5: Nº of cases and deaths by the most hazardous substances

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<td>Paraquat</td>
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<td>5</td>
<td>3</td>
<td>6</td>
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<td>HCl</td>
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<td>2</td>
<td>5</td>
<td>2</td>
<td>11</td>
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Table 6: Compared etiology of cases from TESS and one ED (ED University Clinical Hospital, Zaragoza, Spain)

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<tr>
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<tr>
<td>Accidental Poisoning</td>
<td>80%</td>
<td>25%</td>
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<td>Voluntary Poisoning</td>
<td>20%</td>
<td>75%</td>
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<td>Poisoning by medications and drugs of abuse</td>
<td>49%</td>
<td>73%</td>
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<tr>
<td>Poisoning by other toxics</td>
<td>51%</td>
<td>27%</td>
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Table 7: Different rates of mortality in relation with the source of the data (TESS 2002 and Spanish TSP 1999-2003)

<table>
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<th>TESS 2002 Nº cases / % mortality</th>
<th>TV 1999-2003 Nº cases / % mortality</th>
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<tr>
<td>Methanol</td>
<td>1049 / 1,24%</td>
<td>32 / 15,63%</td>
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<tr>
<td>Paraquat</td>
<td>75 / 2,66 %</td>
<td>22 / 63,64%</td>
</tr>
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<td>CO</td>
<td>15904 / 0,19%</td>
<td>564 / 0,89%</td>
</tr>
<tr>
<td>HCl</td>
<td>298 / 0</td>
<td>52 / 21,15%</td>
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