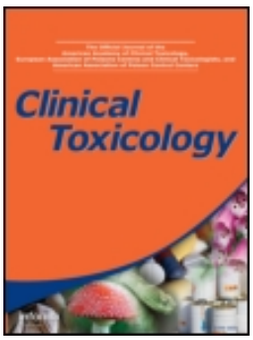

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ARTICLE

# Lamp oil poisoning: Did the European guideline reduce the number and severity of intoxications?

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*Introduction.* In 1997, a European guideline concerning the viscosity and surface tension of lamp oil was adopted to reduce instances and severity of lamp oil intoxications. In 2005, the Dutch National Poisons Information Centre investigated lamp oil intoxications to determine whether they differed in severity from the intoxications reported before the guideline was adopted. *Methods.* We compared the data prospectively collected on lamp oil intoxications reported to our center in 2005 and in 1996. *Results.* In 2005 and 1996, respectively 152 and 165 cases were included. The frequency of the symptoms and diagnosed pneumonitis did not differ significantly between those years. In 2005, ingestion of a transparent lamp oil seemed to be associated with a greater risk of serious respiratory symptoms than ingestion of colored oil. *Conclusion.* Despite the directive, frequency and severity of symptoms of lamp oil ingestions remain disturbing. Consequently, further actions concerning packaging and labeling of lamp oil, design of oil lamps, education of parents, and additions to the current guideline should be considered.

**Keywords** Lamp oil; Intoxication; Poisoning; Bio diesel; Low viscosity petroleum distillates

## Introduction

In the Netherlands, 4% of all requests received by the Dutch National Poisons Information Centre (NVIC) concerning children under 5 years of age are related to unintentional exposure to petroleum products. The total numbers of requests concerning children under 5 years were 7,361 and 13,801 in 1996 and 2005, respectively. Paraffin, a low-viscosity aliphatic hydrocarbon used as a fuel for household oil lamps, is the petroleum product that causes the most unintentional poisonings. Victims are usually young children who take a sip out of curiosity or who perhaps mistake lamp oil for fruit juice because of the decorative color of the oil or lamp (1). Lamp oil ingestions are associated with a considerable risk of aspiration with subsequent chemical pneumonitis and respiratory distress, in some cases leading to respiratory failure requiring mechanical ventilation (2).

Because of an increase in the number of requests concerning lamp oil intoxication from 1994 until 1997, the NVIC studied the background and seriousness of lamp oil intoxications from January 1, 1996, until December 31, 1996 prospectively (3). The NVIC published the results in a report commissioned by Dutch policymakers, which particularly stressed the importance of labeling products with clear warnings about the risks of ingestion. The German and Swiss Poisons Information Centres published comparable advice at the same time (4,5).

In 1997, the European Union adopted a new directive (Brussels, Commission Directive 97/64/EC, document 397L0064) in which guidelines were dictated concerning viscosity and surface tension of colored and fragranced paraffin, which is used as lamp oil. These two properties of hydrocarbons are among the main determinants of its risk of aspiration (6). The directive indicates that the viscosity and surface tension should be more than $7 \times 10^{-6}$ $m^2$/sec and 33 mN/m respectively. A lot of colored lamp oils are currently for sale in Dutch department stores, supermarkets, garden centers, and DIY shops. A small study of lamp oils available in largest Dutch chain stores was performed by the first author of this article in 2007. Most lamp oils consist of liquid hydrocarbons (8 out of 9 in the stores). A few however are manufactured out of seeds (e.g., oilseed rape) and are called 'Bio diesel' or 'Natural paraffin'. Approximately 63% of the lamp oils in stores is colored.

From 1997 until 2002, the NVIC noticed a decrease in the amount of requests for information about lamp oil intoxication. However, this number has increased again since 2002 (Fig. 1).

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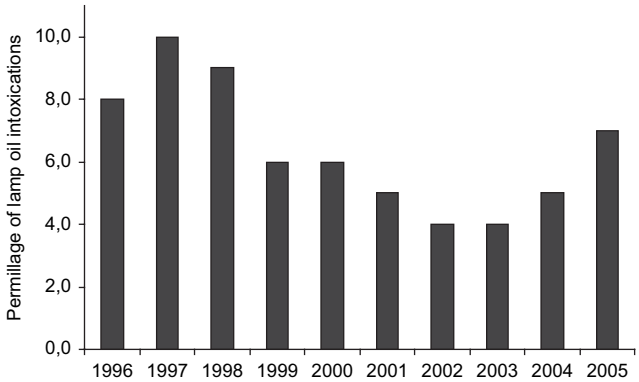


**Fig. 1.** Number of lamp oil intoxications per 1000 persons evaluated at the Dutch National Poisons Information Centre between 1996 and 2005.

The question arises whether the EU guideline is adequate to reduce instances and severity of lamp oil ingestion. In this study, we aimed to characterize the current lamp oil intoxications and to determine whether they differ in frequency and severity from those reported before the introduction of the EU guideline.

## Methods

### *Patients and case definition*

Data on all consecutive cases of lamp oil intoxications reported to our poison centers from January 1, 1996, until December 31, 1996, and from April 1, 2005, until December 31, 2005, were prospectively collected. Our center is the only poisons information center in the Netherlands and its services are only available to healthcare professionals, veterinarians, emergency workers etc. All cases were included, without restriction on age. Exposure was defined by known or suspected oral contact. Exclusion criteria were exposure to multiple products, disease of the tractus respiratorius, or presence of flu.

### *Data collection*

All medical practitioners who contacted our center during the investigation period about patients who were exposed to lamp oil were informed about the possible symptoms and treatment of the intoxication by our information specialists, in accordance with our standard operating procedures. Subsequently, the medical practitioner and the patient (or caregivers of the involved child) were asked to participate in our study. During this first phone call, information about age, sex of the patient, and estimated dose was collected and recorded.

Within two to five days after exposure, the medical practitioners and the patient/caregivers were interviewed using a standardized enquiry form to collect follow-up information. Particularly, information concerning the exposure (ingested amount, type of lamp oil or product name, type of lamp oil), the symptoms, and the additional treatment was collected. Circumstances such as the accessibility of the lamp oil, presence of a child-resistant screw-cap, and the presence of the parents at the moment of the unintentional event were also recorded. In the case of inconsistencies between information obtained from the medical practitioner and the patient/caregiver, the clinical information provided by the physician was considered more reliable, while information about circumstances and type of lamp oil provided by the patient/caregivers was considered more reliable. When neither the physician nor the caregivers or patient could be reached within 10 days or after 10 attempts, the patient was considered as lost to follow-up.

Patients' records were safely stored in our database and not accessible to others. The study was effectively toxicovigilance and this does not require ethical approval in this context.

### *Dose estimation*

Estimation of the ingested amount of lamp oil was made by means of the amount of lamp oil that had disappeared from the bottle or oil lamp and by the information given by the patient or caregivers. Licking one's fingers and sucking a soaked fuse was assumed to be 1 mL, one sip by children up to 2 years of age 5 mL, by children from 2 until 3 years of age 10 mL, and children from 3 years or adults 15 mL (7). The exposure was not confirmed by analysis of blood or urine samples because hospitals in the Netherlands do not have the facilities to routinely determine petroleum distillates in biological samples. In the statistical analyses, the variable "dose" refers to suspected doses, and is coded in three categories "between 0–10 mL", ">10 mL", and "unknown".

### *Analyses*

A Mann-Whitney test was used to test whether the median age differed between 1996 and 2005. The estimated ingested dose was recorded in categories in 1996. Therefore, we used chi-square tests to test differences in frequencies of patients per category of estimated ingested dose between 1996 and 2005. Differences in patient's age and ingested dose between the group with available follow-up information and the group lost to follow-up were also tested by chi-square tests. This could be done only for the 2005 sample as no data were recorded in 1996 about the patients lost to follow-up.

The frequencies of the most usual symptoms and diagnoses were recorded in 1996 and 2005. Relative risks of symptoms and diagnoses between the two periods were tested only when they were observed by medical practitioners and when they were potentially dangerous. Relative risks (and 95% CI) were thus computed for the following symptoms and diagnoses: aspiration, pneumonitis, fever, drowsiness, shortness of breath, and tachypnoe. Relative risks were computed as the 2005 risks divided by the 1996 risks. Risk differences of

symptoms or diagnoses between transparent and colored lamp oil were performed for the year 2005. The risk differences were defined as the risk with transparent oil minus the risk with colored oil.

A Fisher's exact test was used to compare the medical outcomes between the two study periods, in order to determine whether the guideline had an impact. The medical outcomes were coded in five categories: 'no effect', 'minor effect', 'moderate effect', 'major effect', and 'death'. Moderate effects were defined as the occurrence of aspiration, fever, shortness of breath, tachypnea, or pneumonitis. Minor effects were defined as an absence of moderate effects but occurrence of other symptoms such as cough, vomiting, nausea, diarrhea, excitement, sweating, or tachycardia. Major effects were defined as requiring an admission to an intensive care unit. A Spearman correlation coefficient was computed between the use of treatment and admission to a hospital in order to assess whether these two variables were related.

All statistical tests were conducted using SPSS version 12.0.1 (SPSS Inc; Chicago, IL, USA, 2003). A p-value less than or equal to 0.05 was considered to be statistically significant.

**Table 1.** Descriptive data for patients orally exposed to lamp oil in 1996 (N = 109) and 2005 (N = 110)

| | Median (range) | | |
|---|---|---|---|
| | 1996 (2) | 2005 | p-value[1] |
| Age (year) | 1.75 (0.8–75) | 1.86 (0.7–45) | 0.61 |
| | % (n) | | |
| | 1996 (2) | 2005 | p-value [2] |
| Sex | | | 0.29 |
| male | 53.2 (58) | 55.5 (61) | |
| female | 39.5 (43) | 41.8 (46) | |
| missing | 7.3 (8) | 2.7 (3) | |
| Estimated ingested dose | | | 0.31 (6.0) |
| between 0–10 mL | 60.6 (66) | 62.7 (69) | |
| > 10 mL | 11.9 (13) | 13.7 (15) | |
| unknown | 27.5 (30) | 23.6 (26) | |

[1]Mann-Whitney test
[2]Chi-square test

## Results

In 2005, our center received information requests of 49,397 exposures concerning 35,718 persons. In 264 cases, the request concerned lamp oil intoxication (Fig. 1). Within the 9 month period of the study we received 36,959 enquiries, of which 152 concerned lamp oil intoxications. Follow-up information could be collected of 110 cases (72%). The median age and median suspected ingested dose did not differ significantly between the group with follow-up data and the group lost to follow-up (median age = 2 years in 1996 and 2005, p = 0.87; median suspected ingested dose = 5 mL in 1996 and 2005, p = 0.78, respectively). The sex distribution did not differ between these two groups (57% male in the group with follow-up, 63% male in the group of patients lost to follow-up, p = 0.62). In 1996, the NVIC received 25,692 information requests concerning 20,837 persons. In 165 cases, the request concerned lamp oil intoxication (Fig. 1). Follow-up information was collected of 109 cases (66%). Table 1 shows descriptive data about the 1996 and 2005 samples. The relative risk of lamp oil intoxication between 2005 and 1996 equalled 0.93 (95% CI: [0.77;1.13]).

In both years, the majority of the lamp oil intoxications concerned patients younger than 5 years (89% in 1996 and 95% in 2005) and only 4 cases in 1996 and 3 cases in 2005 concerned adults. Neither the median age nor the proportion of male and female patients differed between 1996 and 2005 (Table 1). In both years, the ingested dose was estimated to be between 0 and 10 mL in about 60% of the cases, and >10 mL in about 13% of the cases (Table 1). In approximately 25% of the cases, the ingested dose remained unknown.

The type of lamp oil was often unknown (42% in 2005 and 53% in 1996). In 2005, the lamp oil consisted in 98% of the known cases of liquid hydrocarbon paraffin (63 out of 64 cases). Only one patient ingested lamp oil manufactured out of oilseed rape. Data concerning the color of the lamp oil were collected only in 2005. In 68% of the cases (n = 75 among 110 cases in 2005), the ingested oil was transparent, in 20% (n = 22), the oil was colored, and in 12% (n = 13), the color of the oil was unknown. Of the cases with transparent oil, 32% (n = 24) concerned a lamp made in an uncolored transparent material, 24% (n = 18) concerned a colored lamp, and in 44% of the cases (n = 33), the color of the lamp was unknown.

A majority of the included patients had a drink out of an oil lamp (68% in 1996 and 64% in 2005) and 14% of the patients had sucked a soaked fuse in 2005. In 1996 and 2005 respectively 23% and 14% of the patients drank directly out of the bottle, and noticeably, in 6 cases the child opened the bottle her/himself in 2005, in spite of a child-resistant cap. Two adult patients and one child ingested lamp oil mistakenly out of a cup in 2005, and in 1996, one of the older children and one adult ingested lamp oil during an attempt at fire-breathing. Concerning the exposures of children in 2005, 76% of the oil lamps or bottles were easily accessible placed on a table, windowsill, or in the garden. In 84% of the cases, the parents or caregivers were around during the unintentional event.

Regarding symptoms, 84 of 109 patients (77%) in 1996 and 79 of 110 (72%) in 2005 had symptoms subsequent to ingestion. Table 2 shows the frequency of reported symptoms among the patients for both 1996 and 2005. Cough was both in 1996 and 2005 the most frequent symptom (48% and 53%, respectively), followed by vomiting (18% and 30%,

**Table 2.** Frequency of reported symptoms among patients orally exposed to lamp oil in 1996 (N = 109) and 2005 (N = 110)

| | 1996 % (n) | 2005 % (n) |
|---|---|---|
| Symptoms | | |
| Cough | 48 (52) | 53 (58) |
| Vomiting | 18 (20) | 30 (33) |
| Typical smell of the breath | 14 (15) | 28 (31) |
| Nausea | 10 (11) | 22 (24) |
| Drowsiness[1] | 17 (18) | 19 (21) |
| Fever[1] | 11 (12) | 19 (21) |
| Shortness of breath[1] | 7 (8) | 17 (19) |
| Tachypnea[1, 2] | 6 (7) | 12 (13) |
| Aspiration[1] | 6 (7) | 9 (10) |
| Pneumonitis[1] | 8 (9) | 8 (9) |
| Diarrhea | 5 (5) | 7 (8) |
| Tightness of the chest | 0 (0) | 5 (6) |
| Audible lung abnormality | 6 (6) | 5 (5) |
| Excitement | 6 (6) | 5 (5) |
| Abdominal pain | 3 (3) | 4 (4) |
| Tachycardia | 0 (0) | 4 (4) |
| Retch | 0 (0) | 3 (3) |
| Sweating | 2 (2) | 3 (3) |
| Hospital | | |
| Admission[1, 2] | 39 (42) | 23 (25) |
| Chest X-ray[1, 2] | 32 (35) | 14 (15) |
| Chest X-ray abnormalities[1] | 12 (13) | 8 (9) |
| Treatment[1, 2, 3] | | |
| Antibiotics | 22 (24) | 7 (8) |
| Purge | 11 (12) | 1 (1) |
| Paraffin administration | 6 (6) | 0 (0) |
| Activated charcoal | 2 (2) | 0 (0) |
| Prednisone | 2 (2) | 0 (0) |
| Administration of olive oil or oil for sald | 1 (1) | 0 (0) |
| Gastric lavage | 1 (1) | 0 (0) |
| Whipped cream | 0 (0) | 1 (1) |

[1]Test whether the relative risk (RR) between 2005 and 1996 differed from 1 has been performed.
[2]RR significantly different from 1.
[3]Use of any treatment was compared between 1996 and 2005.

respectively). The risks of aspiration and pneumonitis did not differ significantly between 2005 and 1996 (RR = 1.42, 95% CI [0.56 ; 3.58] and RR = 0.99, 95% CI [0.41 ; 2.40], respectively). The risks of depression of the central nervous system (mostly reported as drowsiness), tachypnea, and fever were comparable in both years (RR = 1.16, 95% CI [0.65 ; 2.05], RR = 1.84, 95% CI [0.76 ; 4.44], and RR=1.73, 95% CI [0.90 ; 3.35], respectively). Shortness of breath was significantly more often reported in 2005 (RR=2.35, 95% CI [1.08 ; 5.15]). The number of medical outcomes did not differ significantly between the two study periods (Table 3). There were no admissions to intensive care units nor any fatalities in 1996 and 2005.

**Table 3.** Number of medical outcomes in 1996 and 2005

| Outcome[1] | 1995 (N = 109 patients) | 2005 (N = 110 patients) | p-value[2] |
|---|---|---|---|
| No effect | 25 | 31 | 0.7 |
| Minor effect | 45 | 41 | |
| Moderate effects | 39 | 38 | |
| Major effects | 0 | 0 | |
| Death | 0 | 0 | |

[1]See text for the definitions of the five categories of effects.
[2]Fisher's exact test.

In 2005, ingestion of a transparent lamp oil was associated with a greater risk than ingestion of a colored lamp oil. The risk differences of drowsiness, vomiting, aspiration, and pneumonitis between transparent and colored oil were respectively: 14.1, 95% CI [1.7 ; 26.5]; 21.0, 95% CI [3.1 ; 39.0]; 9.3, 95% CI [2.7 ; 15.9], and 5.3, 95% CI [0.2 ; 10.4].

Regarding medical care, 25 of 110 (23%) and 42 of 109 (39%) children were admitted to a hospital in 2005 and 1996, respectively (RR = 0.59, 95% CI [0.39 ; 0.90]) (Table 2). X-rays of the thorax were performed less often in 2005 than in 1996 (RR = 0.42, 95% CI [0.25 ; 0.73]) but the risk of abnormality in X-rays did not differ between 2005 and 1996 (RR = 0.69, 95% CI [0.31; 1.54]).

Regarding treatment, less unconventional therapies like vomiting or gastric lavage were observed in 2005 than in 1996 (RR = 0.19; 95% CI [0.10 ; 0.38]). These therapies were not advised by our poisons center, but performed on the physician's or parent's initiative. In 1996 as well as in 2005 the average duration of observation at hospital was one day. Use of treatment and admission to a hospital were highly correlated in 2005 ($r = 0.51$, $p < 10^{-3}$) but not in 1996 ($r = 0.26$, $p = 0.09$).

## Discussion and conclusion

After adoption of an EU guideline in 1997 to limit the number and severity of lamp oil intoxications, the frequency of requests for information about lamp oil intoxications decreased at our center. Part of the decline was probably due to the governmental information campaign "Poisonous Seducers" run by the Consumer Safety Institute from 2000 until 2002. However, since 2002 the proportion of lamp oil intoxications for 1000 requests has increased again (Fig. 1) and the number of requests had not significantly decreased in 2005 compared to 1996 (R = 0.93, 95% CI [0.77–1.13]). Seen this way, the European directive does not seem to have been effective.

Lamp oil intoxications seem not to have varied in circumstances or severity when comparing 2005 to 1996. Patients were usually children aged 1–2 years (about 56%) who, in 66% of the cases, drank lamp oil directly from an oil lamp, usually found on a table or windowsill. The frequency of severe

symptoms or diagnoses like pneumonitis, aspiration, depression of the central nervous system, and tachypnea, observed or diagnosed by physicians, did not differ between 1996 and 2005.

The main difference observed between 1996 and 2005 was how lamp oil intoxications were dealt with. Currently, physicians are more reserved when advising hospitalization and performing X-rays (significantly less hospitalization and fewer X-rays in 2005 than in 1996). The decision for admission and performance of X-rays was made on the physicians' initiative. It is difficult to explain this decrease. It may be related to developments in the physicians' knowledge of such intoxications. Another possible explanation is the decrease in use of unconventional treatments before the arrival at the emergency unit. In 1996, the unconventional treatments observed were not recommended by our poisons information center. They were often performed outside the hospital by the parents or caregivers, and sometimes by the General Practitioner. In 1996, use of treatment and hospitalization were not significantly correlated ($r = 0.26$, $p = 0.09$) while in 2005, significantly fewer treatments were used, and use of treatment and hospitalization were highly correlated ($r = 0.51$, $p < 10^{-3}$). Our poisons information center advises to take an X-ray when cough, fever, and/or shortness of breath are present. In general, treatment is supportive. Measures to prevent absorption are not indicated, as vomiting increases the risk of aspiration and administration of charcoal is useless, because it does not bind with hydrocarbons. In addition, inducing vomiting or gastric lavage should not be performed, because the effectiveness has not been proven and it can increase the risk for complications (8,9).

Lamp oil continues to be attractive to children because of the color. Young children recognize drinks by color much more than older children and adults (10). Therefore a red lamp oil in a bowl can be easily be mistaken for a glass of a red-colored soft drink or fruit juice, such as cranberry juice for instance. In 2005, the majority of the exposures to lamp oil concerned a colored oil or lamp (63% of the cases of which these properties were known). Since 1997, lamp oil sold in shops should follow the EU guideline concerning the viscosity and surface tension. However, because the frequency and gravity seem unchanged in our study, it is questionable whether producers of lamp oils are complying with the guideline.

Is the EU guideline adequate? First, it does not cover transparent lamp oil, while our results precisely suggest that ingestion of transparent lamp oil has a greater risk of causing serious symptoms than ingestion of colored oil. Since transparent lamp oils are not covered by the EU guideline, they may therefore have a low viscosity and surface tension with a higher risk of aspiration. Determination of the chemical properties of transparent lamp oils on the market could give an answer about this issue. Secondly, the labeling of products is also of importance. Some of the labels on the lamp oil containing natural paraffin state that the product is not toxic. Due to these labels parents may not be aware of the risk of complication after ingestion and therefore may not store lamp oil in a place inaccessible to young children. Moreover, this absence of warning on the label could result in an under-reporting of these intoxications with natural paraffin at our center. Information about the market share of these products could give an impression about the frequency of ingestion with natural paraffin.

Our results corroborate another study conducted in 2004 by the German Federal Institute for Risk Assessment (BfR) (2). In spite of the prohibition of colored and fragranced lamp oil with a substantial risk of aspiration, the institute still received a large number of reports on lamp oil poisoning, and two cases of poisoning resulted in death. The BfR concluded that further measures should be taken and proposed to prohibit lamp oil with low viscosity and surface tension independent of their color or odor.

Some limitations of the study should be mentioned. First, the estimation of the ingested amount was troublesome because the intake of lamp oil by young patients is frequently not witnessed by the parents or caregivers. Besides, the majority of the young children probably spill an unknown part of the lamp oil while drinking. Nevertheless, in the literature, no clear dose–effect relationship has been established between the ingested dose and the pulmonary toxicity. Pulmonary toxicity has been reported with low ingested doses (2,3). Second, the color of the lamp oil and lamp in case of transparent oil were unknown in 12% and 44% of the cases, respectively. Analyses concerning the potentially higher risk of transparent lamp oil versus colored lamp oil are therefore based on relatively few patients, as illustrated by the width of the 95% confidence intervals of the risk differences. These results should therefore be confirmed in a study including more cases.

The results of our study imply that further actions are needed to minimize the occurrence and severity of lamp oil intoxications. First, it should be checked whether producers of lamp oils are complying with the 1997 EU guideline. Prohibition of lamp oil with low viscosity and surface tension independent of their color or odor might be a big step forward to prevent severe sequela. The packaging of lamp oil, the design of oil lamps and the labeling of natural paraffin containers should also be improved. Finally, the education of parents to reduce the frequency and severity of these intoxications is an issue that needs continuous attention.

We conclude that despite the new directive about viscosity and surface tension of colored lamp oil on basis of hydrocarbons, frequency and severity of symptoms of lamp oil ingestions remain disturbing. Consequently, further actions concerning packaging and labeling of lamp oil, design of oil lamps, education of parents, and additions to the current guideline should be considered.

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