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Fatal poisonings in Jutland (Denmark) during the 1980s

Elisabet Kaa and Markil Gregersen

Department of Forensic Medicine, Aarhus University, Skovagervej 2, DK-8240 Risskov, Denmark

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Summary. During the period 1980 through 1989 a total of 1029 cases of fatal poisoning (638 men and 391 women) were examined at the Department of Forensic Medicine, Aarhus University, Denmark. In 68% of the cases death had been caused by drugs, whereas acute alcohol poisoning and carbon monoxide accounted for 15% and 14% of the cases, respectively. Alcohol was detected in more than half of the 1029 fatal poisoning cases, and in 42% of all cases the blood alcohol concentration was above 0.8 g/kg. In 57% of the cases death was categorized as accidental, only in 31% of the cases as suicide. Accidental deaths were especially predominant amongst drug and/or alcohol abusers. Propoxyphene was the drug found to have caused most fatal poisonings during the decade (30% of the drug-related deaths). Most of the propoxyphene-related deaths occurred during the early and mid-eighties. Barbiturate poisonings were quite frequent during the first half of the eighties. However, the number of deaths caused by barbiturates decreased significantly after 1986, when most barbiturates were withdrawn from the market. The number of deaths caused by narcotics and analgesics increased during the survey period, while no specific tendency was observed concerning antidepressants.

Key words: Poisoning mortality – Propoxyphene poisoning – Barbiturate poisoning – Cause of death – Manner of death

Zusammenfassung. Während des Zeitraums 1980 bis 1989 wurden insgesamt 1029 Fälle tödlicher Vergiftungen (638 Männer und 391 Frauen) in der Abteilung für Forensische Medizin der Universität Aarhus, Dänemark, untersucht. In 68% der Fälle war der Tod durch Medikamente verursacht, während Alkoholvergiftung und Kohlenmonoxid für 15% bzw. 14% der Fälle standen. Alkohol wurde in mehr als der Hälfte aller 1029 tödlichen Vergiftungsfällen gefunden und in 42% aller Fälle war die Blutalkoholkonzentration höher als 0.8 g/kg. In 57% der Fälle war der Tod als Unfalltod kategorisiert, in nur 31% der Fälle als Suizid. Unfalltodesfälle waren besonders herausragend bei Personen mit Drogen und/oder Alkoholmißbrauch. Propoxyphen war die Droge, welche die meisten tödlichen Vergiftungen während des Jahrzehnts verursacht hatte (30% der medikamentenbezogenen Todesfälle). Die meisten der Propoxyphen-bezogenen Todesfälle ereigneten sich in den frühen und mittleren 80er Jahren. Barbiturat-Vergiftungen waren ziemlich häufig während der ersten Hälfte der 80er Jahre. Jedoch nahm die Zahl der Todesfälle durch Barbiturate signifikant nach 1986 ab, als die meisten Barbiturate vom Markt genommen wurden. Die Zahl der Todesfälle durch Narkotika und Analgetika nahm während des Übersichtszeitraums zu, während mit Antidepressiva keine spezifische Tendenz beobachtet wurde.

Schlüsselwörter: Vergiftungsmortalität – Propoxyphen-Vergiftung – Barbiturat-Vergiftung – Todesursachen – Todesart

Introduction

According to the official statistics based on information from death certificates, the annual number of fatal poisonings in Denmark is approximately 900 [1]. One-third of these deaths occurred in the area covered by the Department of Forensic Medicine, Aarhus University [The National Board of Health. Personal communication]. In Denmark the police must be notified with regard to whether a legal inquest must be held, in cases of sudden unexpected death, when a person has been found dead, in cases of accident, suicide or a suspected crime, or when an occupational disease may have been the cause of death. If the circumstances surrounding a death are unclear, the police authorities will request a medicolegal autopsy, and possibly supplementary forensic toxicological analyses. In Denmark medicolegal autopsies and toxicological analyses are carried out in less than half of all poisoning cases [The National Board of Health. Personal communication]. Fatal poisonings subjected to medicolegal autopsy are therefore preselected material [1–3]. However, since 1970 medicolegal autopsy accompanied by forensic toxicological investigation has been compulsory in all cases in which death is assumed to be related to the abuse of euphoriant drugs.

The purpose of this study was to show trends in the pattern of poisoning deaths examined at the Department

Correspondence to: E. Kaa

of Forensic Medicine, Aarhus University during the eighties and in addition, to relate these results to the availability of drugs during the decade. Some of the results covering the early part of the eighties have previously been published [3–8].

Materials and methods

The material in this survey consists of fatal poisonings examined at the Department of Forensic Medicine at Aarhus University. The department covers the peninsula of Jutland, excluding the southern part, with a population of approximately 2 million. During the ten-year period 1980 through 1989, a total of 2875 cases of fatal poisoning were registered in this area; of these 1029 cases were submitted for forensic examination [The National Board of Health. Personal communication]. On the basis of available information from police, physicians, relatives, etc., two-thirds of the deceased were assumed to have been abusers of drugs and/or alcohol.

With regard to the definition of poisoning in this survey, not only the concentrations in which substances were found, but also an appraisal of the circumstances surrounding the death were of relevance. Cases in which the deceased had been in hospital before death are included when the circumstances indicated poisoning, e.g. the presence of drugs in stomach aspirates, the finding of a syringe containing narcotics etc. Also included are cases in which the immediate cause of death was aspiration, hypothermia or bronchopneumonia, but the underlying cause was poisoning. On the other hand, deaths resulting from illness which might have been aggravated by drugs and alcohol are not included.

Drug poisoning in this survey includes poisonings caused by medical as well as illicit drugs (heroin, amphetamine, etc.) In 16% of the drug-related deaths two or more drugs were detected in concentrations considered fatal or in concentrations so low that one drug alone would probably not have been fatal. These multiple drug deaths were classified according to the drug which was estimated to have been most significant. Most of the poisonings involving both drugs and alcohol (ethanol) were classified as drug-related deaths. Only cases with a drug concentration estimated to be insignificant were classified as deaths caused by alcohol.

In all cases a complete medicolegal autopsy was carried out. However, the extent of the toxicological examinations was decided according to the circumstances of each individual case (Table 1).

Table 1. 1029 cases of fatal poisoning in Jutland during the period 1980–1989. The frequency with which each substance caused death, the occurrence of each substance, and the frequency with which each substance was included in the toxicological screening procedure

	Cause of death %	Occurrence %	Screening %
Propoxyphene	20	21	69
Alcohol	15	52	97
Carbon monoxide	14	15	15
Barbiturates	10	14	51
Heroin/morphine	8	11	25
Methadone/ketobemidone	6	9	69
Antidepressants	6	7	69
Analgesics	4	12	44
Hypnotics	3	7	33
Neuroleptics	2	6	69
Benzodiazepines	2	20	54
Insecticides/herbicides	2	2	7
Amphetamine	<1	2	10

Results

In 68% ($n = 696$) of the poisoning cases death was caused by drugs, while 32% ($n = 333$) of the cases were caused by other substances (alcohol, carbon monoxide, insecticides/herbicides, volatile substances, etc.). A total of 93 different chemical substances were found in the 1029 cases. Table 1 shows the frequency with which each of the most prevalent substances caused death, the occurrence of the individual substances, and the frequency with which each substance was included in the toxicological screening procedure. The most frequently detected substances appeared in the following order: alcohol, propoxyphene, benzodiazepines, carbon monoxide, barbiturates. The substances most frequently found to have caused death were propoxyphene, alcohol, carbon monoxide, barbiturates and heroin/morphine.

Men accounted for 62% ($n = 638$) of the cases and women for 38% ($n = 391$), 14 of the deceased were children under 10 years of age. In two-thirds of the cases (443 men and 227 women) the available information indicated the abuse of alcohol (473 cases) and/or drugs (384 cases). The abuse usually involved several substances.

More than half of the fatal poisonings were categorized as accidents (57%), whereas only 31% were suicides. Less than 1% of all cases were homicides (including 3 children), and in 11% of the cases the manner of death could not be determined. The frequency of accidents was higher among abusers of drugs/alcohol (71% accidents, 18% suicides) than among non-abusers (33% accidents, 56% suicides). The frequency of accidental deaths was higher for men (63%) than for women (48%).

Of the deceased 98% were Danes, 2% were other nationalities, mostly Norwegian. At the time of their death, half of the deceased were unemployed or receivers of a disability or old age pension, 20% were skilled workers, 15% unskilled workers and a few were students or selfemployed.

Most of the deceased died in their own homes (60%), 12% in the homes of family or friends, 8% in hospital, and 3% in a public lavatory (mainly drug addicts). A few died in a hotel, in a shelter, in prison, out of doors, or in a car (mainly carbon monoxide poisonings).

Drug-related poisonings

The material in this survey consists of 412 men and 284 women including 4 children who died from drug poisoning. These cases comprise 39% of the total number of drug poisonings in the area during the period. In the groups under 35 years of age men accounted for more than twice as many deaths from drug poisoning as women (227 men, 100 women). For the older age groups the number of deaths was the same for men and women (185 men, 184 women).

The frequency of deaths categorized as accidents was higher for men (57%) than for women (37%). For women older than 30 years of age the frequencies of accident and suicide were approximately the same, whereas for younger women suicides prevailed. For men

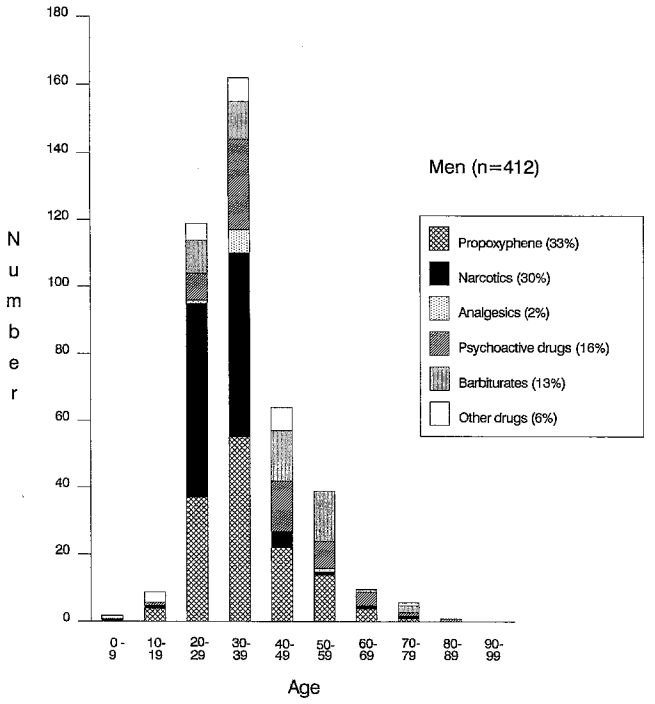

Fig. 1. Age distribution in 412 cases of fatal drug poisoning in men

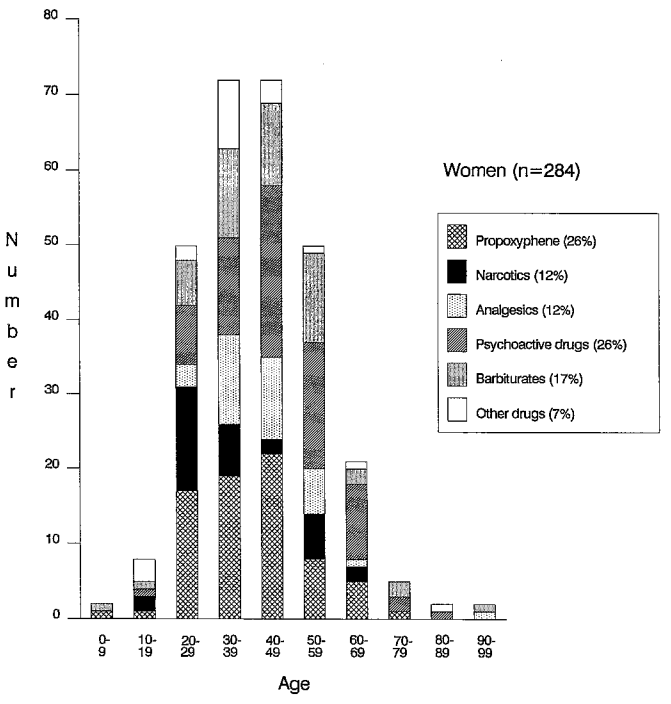

Fig. 2. Age distribution in 284 cases of fatal drug poisoning in women

younger than 40 years of age two-thirds of the drug-related deaths were accidents, whereas suicides were predominant in the older age groups.

Figures 1 and 2 show the causes of death related to age for both sexes. Figure 3 shows trends in drug related deaths during the survey period.

Propoxyphene was the drug which caused most fatal poisonings for both men and women. During the survey period 30% of all drug-related deaths were caused by propoxyphene. The majority of propoxyphene deaths amongst men were accidents (56% accidents, 32% suicides), whereas for women suicides were more frequent (54% suicides, 31% accidents). The frequency of propoxyphene deaths was no higher for drug/alcohol abusers than for non-abusers. However, accidental deaths predominated amongst abusers whereas for non-abusers most deaths were suicides. Most of the propoxyphene-related deaths occurred during the early and mid-eighties. In 1985 propoxyphene thus accounted for half of all drug-related deaths examined in our department (Fig. 3).

Deaths caused by *narcotics* (strong analgesics) increased from 16% of the drug-related deaths in the first half of the decade to 29% in the second half. Most of the poisonings classified as heroin/morphine (Table 1) were assumed to have been caused by heroin. This was indicated by the finding of a syringe or other paraphernalia associated with heroin. During the ten-year period no specific trends were observed for heroin/morphine-related deaths. The number of methadone-related deaths however increased significantly during the late eighties. During the period 1985 through 1989 the number of deaths caused by methadone or ketobemidone was equal to the number of heroin/morphine cases. Deaths caused by narcotics were predominant among men (Figs. 1 and 2). For both sexes, the major proportion of deaths caused by narcotics occurred among young people, and nearly all were drug addicts. The majority of the narcotic deaths were categorized as accidents (82% of the cases). In most cases in which narcotics were detected, they were assumed to have been the cause of death (Table 1).

Analgesics were detected in 12% of all cases, but only in one-third of these cases were they estimated to have been the primary drug (Table 1). Acetylsalicylic acid accounted for the majority of deaths caused by analgesics; only 7 deaths were caused by paracetamol. The number of deaths was higher in the latter half of the eighties (31 cases) than in the first half (12 cases). Deaths caused by analgesics were most frequent among middle-aged women (Fig. 2) and most of these deaths were accidental.

Barbiturate poisoning accounted for 20% of the drug-related deaths in the period 1980 through 1985, compared with only 5% in the following years. For women, the number of accidents and suicides caused by barbiturates was approximately equal, whereas for men, suicides were nearly twice as frequent as accidents.

Psychoactive drugs accounted for 20% of all drug-related deaths. In 43% of these cases death was caused by antidepressants (amitriptyline, doxepine etc.), 24% were caused by hypnotics (chlorale hydrate, methaqualone, methyprylone etc.), 17% by neuroleptics (chlorprotixene, levomepromazine etc.) and 16% by benzodiazepines (diazepam, nitrazepam etc.). Most of the deaths caused by antidepressants were suicides among women. Antidepressants were estimated to have been the primary cause of death in almost all cases in which they were detected (Table 1). Other types of psychoactive drugs were estimated to have been the cause of

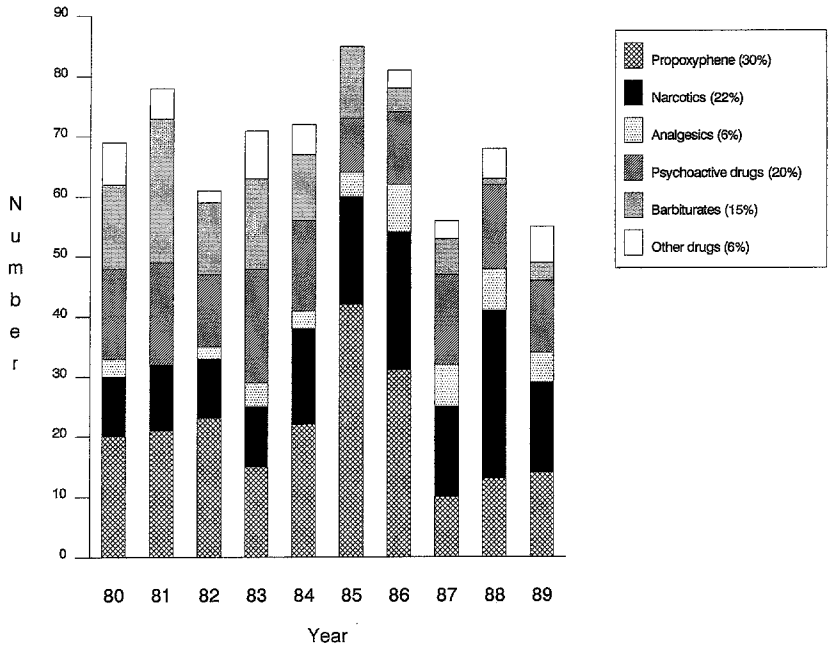

Fig. 3. Causes of death in 696 cases of fatal drug poisoning in the period 1980–1989

death less frequently than they were detected. Benzodiazepines, in particular, were detected quite often, i.e. in 38% of the drug-related cases in which the toxicological screening procedure included this type of drugs. Benzodiazepines were thus, after alcohol, the most prevalent substances during the survey period.

The group "other drugs" includes 3 deaths caused by *amphetamine*. No deaths caused by cocaine, designer drugs or cannabis were found.

Alcohol was detected in half of the drug-related deaths among men and in one-third of the cases among women. In 71% of the cases in which alcohol was detected the blood alcohol concentration (BAC) was above 0.8 g/kg.

Non-medical poisonings

Alcohol was detected in more than half ($n = 540$) of the 1029 poisoning cases, and in 433 cases (42%) the BAC was above 0.8 g/kg. According to the classification methods of this survey (see Materials and methods) acute alcohol poisoning was estimated to have been the cause of death in only 143 (15%) cases (98 men, 53 women). These cases comprised 82% of the total number of alcohol poisonings in the area during the period. In 138 of the fatal alcohol poisonings in this survey available information indicated alcohol abuse. For both sexes most deaths occurred in the 40–49 year age group. Nineteen men but only one women younger than 30 years of age died from acute alcohol poisoning. The immediate cause of death was often aspiration or hypothermia, and only in 40% of the cases was the BAC higher than 3.0 g/kg. Almost all deaths caused by acute alcohol poisoning were categorized as accidents.

Death was classified as caused by *carbon monoxide* in 95 cases connected with fire (62 men and 33 women) and in 45 cases unconnected with fire (34 men and 11 women). These cases comprise 17% of the total number of carbon monoxide poisonings in the area during the period. Almost all cases connected with fires were accidents. The victims were often children or elderly people (7 children and 12 people over seventy years of age). In two-thirds of the cases unconnected with fire the deceased, mostly men, were found in a car or in a garage. These cases were mostly suicides.

Other non-medical poisonings included 25 deaths caused by *insecticides/herbicides*, 13 deaths caused by *volatile substances* (methanol, benzene, chloroform, ethylene glycol, isobutane, fluorcarbons etc.) and 4 deaths caused by *arsen, thallium, fluoride* and *cyanide*. Deaths caused by pesticides were mainly suicides caused by parathion, but 2 of the cases were accidents involving children. Cases with volatile substances were mainly accidents and 5 of these deaths occurred in connection with substance abuse by sniffing.

Discussion

The pattern of poisonings in a country is influenced by the availability of drugs and poisons. The availability is controlled by various regulations and control systems for both licit and illicit substances. In most western countries poisoning deaths are mainly caused by carbon monoxide, medical drugs, narcotics and alcohol, whereas in other parts of the world non-medical substances such as agrochemicals are of primary importance [9, 10].

In general, comparison with other studies on poisonings is difficult due to differences in the categorization of deaths, different survey periods and differences in the selection of material (e.g. some studies include carbon monoxide poisonings caused by fires, others do not). Moreover, results from different laboratories are influenced by the extent of the screening procedures

applied and the fact that varying methods with different detection limits are employed. However, in this and in other studies, alcohol has been a highly prevalent substance [6, 11–15]. In this study alcohol was detected in more than half of the 1029 fatal cases, and in 42% of all cases the BAC was above 0.8 g/kg, the legal limit for drivers in Denmark. In accordance with other studies this study showed a decrease in the number of barbiturate- and propoxyphene-related deaths [6, 11–13, 15]. Unlike some other studies however, the results of this study show no increase in the number of antidepressant-related deaths [6, 12, 13].

In Denmark, a number of changes concerning the availability of drugs occurred during the eighties. Analgesics (paracetamol and acetylsalicylic acid in combination with codeine) became over-the-counter drugs in 1984 and most barbiturates were withdrawn from the market in 1986. The dispensing regulations for addictive drugs, including benzodiazepines, were tightened in 1987, and in 1988 new and stricter prescription rules for propoxyphene came into force. In the illicit market heroin was predominant among the "hard" drugs until 1987, but during the late eighties a marked increase was seen in the abuse of amphetamine [16, 17]. The abuse of cocaine has only been a minor problem in Denmark during the eighties, and no cocaine-related deaths were seen during the period.

The annual number of *heroin*-related deaths did not change significantly during the eighties, whereas the increasing number of methadone-related deaths reflects the extensive use of *methadone* in drug addict treatment programmes during the late eighties. Although the intake of methadone is supposed to be controlled this is not always the case and seizures of methadone are frequently made in the illicit market [17]. A stricter control of the intake of methadone might help stop the flow of methadone into the illicit market, and thus result in a decrease in the number of methadone-related deaths, as previously shown in a study on poisonings in Texas [13].

The problem of fatal poisonings caused by *analgesics* has not been as extensive in Denmark as has been described in other countries, especially England [15, 18, 19]. In the early eighties sales of products containing acetylsalicylic acid far exceeded sales of paracetamol. In the late eighties, however, sales of both drugs were approximately equal, due to a significant increase in the sale of paracetamol and a minor decrease in the sale of products containing acetylsalicylic acid [20]. In Denmark paracetamol is not sold in combination with propoxyphene or other drugs. This is a likely explanation for the different frequencies of fatal paracetamol poisonings in England and in Denmark.

Propoxyphene is not distributed in combination with other drugs in Denmark either. During the ten-year survey period propoxyphene caused more fatal poisonings than any other drug. On this basis, the National Board of Health warned physicians not to prescribe propoxyphene to abusers of drugs or alcohol or to persons who had previously attempted suicide. These warnings did not however have an adequate effect. The large number of accidental propoxyphene deaths eventually led to a debate in the media, and finally to a tightening of dispensing regulations in 1988. As a result of the new regulations a copy of each prescription for propoxyphene must be sent to the National Board of Health. In this way authorities are able to check the number of prescriptions from each individual physician. A decrease in sales and in the number of propoxyphene-related deaths was noted following the public debate, even before the regulation actually came into force [5]. Nevertheless, propoxyphene still accounted for a quarter of all drug-related deaths examined at our department in 1989. Moreover, the latest nationwide statistics from the National Board of Health indicate that the decrease observed in 1987 might not continue [21]. The results achieved by warnings from the National Board of Health, stricter rules for prescriptions and extensive coverage in the media may thus only have had a temporary effect. Corresponding with the Danish trend, an American study on trends in the prescribing of propoxyphene and in overdose deaths related to propoxyphene, before and after a warning campaign covered extensively by the media, showed a decline in the sales and in the number of deaths during the warning period [22]. However, this trend only lasted until the end of the campaign. The authors concluded that a sharper decline in the misuse of drugs such as propoxyphene would require stronger, more sustained regulatory or educational measures. In Denmark, the coming years will show whether further steps need to be taken towards limiting the availability of propoxyphene.

During the ten-year survey period a decline was noted in the sale of *psychoactive drugs,* measured as recommended by the WHO as defined daily dose (DDD) per 1000 inhabitants [23]. The trend was mainly due to the withdrawal of most barbiturates from the market in 1986. In addition, the sales statistics were influenced by the withdrawal of products containing 10 mg of diazepam and the introduction of regulations in 1987 restricting the distribution of other benzodiazepines. Throughout the decade benzodiazepines were the most widely sold psychoactive drugs (79% of sales in 1989). Antidepressants and neuroleptics each accounted for less than 10% of sales, with no significant changes during the eighties.

Barbiturates were withdrawn from the market in Denmark and in many other countries because of high mortality rates, most barbiturate-related deaths being suicides. The results of this study do not indicate that any other specific drug has replaced barbiturates regarding their use for suicidal purposes. Regarding therapeutic use, benzodiazepines seem to have replaced the barbiturates to a large extent. Although hospitalizations due to benzodiazepine poisonings are quite frequent, the mortality rate is low, considering the availability and extensive use of these drugs [24].

The number of fatal poisonings in this study corresponds to 36% of all fatal poisonings in the area covered by the Department of Forensic Medicine during the decade. When evaluating the results, one has to bear in mind that the fatal poisonings subjected to medicolegal autopsy in Denmark are a selected material. Alcohol poisonings accounted for a relatively large part of the

forensic material, whereas carbon monoxide poisonings were examined less frequently. Moreover, in this forensic material accidental deaths predominated, whereas suicides accounted for two-thirds of all fatal poisonings during the eighties [1].

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