POISONING, OVERVIEW AND STATISTICS

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Introduction

It is difficult to obtain reliable information on the morbidity and mortality resulting from poisoning, even in countries with comparatively advanced population health data collection systems. Despite difficulties in the interpretation of available data, certain general observations can be made on the epidemiology of poisoning. Childhood poisoning is usually accidental, and tends to be associated with low morbidity and mortality. In western Europe and North America it is most often due to household products and pharmaceuticals: in developing countries, pesticides and household products are most commonly involved. In adults, self-poisoning is usually deliberate (suicide or parasuicide) and has higher morbidity and mortality. Analgesics and psychotropics predominate in western Europe and North America as cause of admission to hospital, though carbon monoxide is responsible for most deaths occurring outside hospital. In developing countries accidental and deliberate pesticide poisoning remains the commonest cause of adult deaths by poisoning. The mortality rate for deliberate self-poisoning in developing countries is estimated at 10–20%, largely with pesticides but including all sources, in contrast with the 0.5–1% commonly found in western Europe and North America.

In some countries, the rate of acute poisoning has increased. For example, the number of acute poisoning cases in Moscow and large Russian cities has increased almost twofold in the last 15 years. The main groups of toxic agents causing poisoning are pharmaceutical (up to 63.1%), alcohol and surrogates (up to 49.3%), and corrosives (up to 21.8%); figures vary between different Russian regions. Mortality from poisoning in Russia has also increased in recent years; the main causes of fatalities are alcohol (62.2%), carbon monoxide (15.4%), acetic acid (6.3%), and pharmaceuticals (4%).

The Global Burden of Disease study points to 75% of worldwide deaths during 1990 being due to self-harm, including poisoning, alcohol abuse, smoking, and obesity. It is estimated that 99% of all fatal poisonings occur in developing countries. The incidence and pattern of suicide vary from country to country. Cultural, religious, and social values play some role in this regard.

Acute poisoning is the leading cause of unnatural deaths and third most common cause of emergency admissions in rural India; insecticides were responsible for 35% of clinical and 55.4% of fatal cases. Young married males of rural background with agricultural occupation and failure of monsoon were the identified risk factors associated with poisoning cases. A 25-year autopsy study (1972–1997) of acute poisoning deaths from a tertiary care hospital in Northern India showed a steep increase in incidence of poisoning since 1987. Again, most were 14–30-year-old males. The main victims were students and unemployed youths, followed by agricultural workers and domestic workers. The proportion of suicidal deaths increased from 34% (1972–1977) to 77% (1992–1997), whereas accidental deaths decreased from 63% to 17% in the same period. Barbiturates (37%) and copper sulfate (22%) were the most common poisons causing mortality between 1972 and 1977: organophosphates (46%) became the most common between 1977 and 1982. Since 1982 aluminum phosphide has been the most common poison.

There is a paucity of information on suicide from Pakistan, an Islamic country in which data collection poses challenges as a variety of social, legal, and religious factors make reporting and diagnosing suicide difficult. Thus newspaper reports are just about the only way of having a feel for numbers. Over a 2-year period 306 suicides were reported from 35 cities; more than half used organophosphates, while psychotropics and analgesics were used infrequently. The study challenges the widely held belief that suicide is a rare phenomenon in an Islamic country, and underscores the need for more culture-specific research on this important public health problem.

Childhood poisoning also varies significantly worldwide. Children under 5 years had higher hospitalization rates in New Zealand than adults, but were less at risk of death than any other age group. Similarly, in Finland, children under 6 years were the most frequently hospitalized because of poisoning; the commonest causes were plants, berries, mushrooms, and corrosives. In a study of attendances at a pediatric emergency department in Trieste, Italy, between 1975 and 1994, trends showed a decrease in pharmaceutical poisonings, probably due to the introduction of child-resistant containers, and an increase in domestic poisons. There was also an increase in carbon monoxide inhalation and alcohol poisonings amongst teenagers. In a poisons center study in Spain, 35.2%

of all poisoning occurred in children under 2 years of age. In Bordeaux, France, acute poisoning in children is still a public health problem. The overall mortality rate was 0.33/1000 but most cases of acute poisoning were accidental, benign, and mainly attributed to ingestion of a nontoxic substance. In Tehran, Iran, after drugs (32.1%), hydrocarbons were the most frequent cause of poisoning (19.2%). In a poisons center study in Taiwan, Japan, substances most frequently found to have been ingested by children were household products, benzodiazepines, and pesticides, with a recorded mortality rate of 1.4%. In Costa Rica children under 5 years accounted for 39.2% of cases reported to a poisons center.

Retrospective data on childhood poisoning from eight regional hospitals in India revealed that pediatric poisoning represented 0.23–3.3% of the total poisoning. The mortality ranged from 0.64% to 11.6%. Kerosene was one of the causes of accidental poisoning where wood charcoal is not used. Pesticide poisoning was more prevalent in Punjab and West Bengal, whereas plant poisoning was very common in Shimla. Significant snake envenomation was recorded from rural Maharashtra. Thus, within India, various regions show variation in types and frequency of childhood poisoning. Many of these studies highlight the unacceptably high rate of preventable accidental poisoning of children.

Poisoning Data Collection for Epidemiology

Enquiries made by healthcare professionals (e.g., in the UK) and in some instances by members of the public (e.g., in New Zealand) to poisons centers provide some information on acute poisoning. The best routinely collected epidemiological data on poisoning come from the Toxic Exposure Surveillance System (TESS) in the USA. This recorded telephone calls made for advice from members of the public and healthcare professionals about poisoning across a population of 260 million Americans in 2000.

However, data are collected differently in different healthcare systems. For example, in the UK the National Poisons Information Service only takes calls from healthcare professionals, whereas Australia and the USA offer a combined public and professional access service. In all countries calls to poisons centers tend to overestimate the size of the poisoning problem, because calls are made where significant exposure has not taken place, "for advice" just in case. In contrast, hospital admission data tend to underestimate the size of the real population of poisoned individuals as many do not need or seek medical help. Few centers have the resources to obtain reliable follow-up data, and thus the clinical course and outcome are often unknown. Toxicological analysis to confirm exposure is rarely performed, except where the results may influence management.

Data on poisoning in developing countries are generally poor and most data are in case series format that gives at best a snapshot of events and may not represent current trends. There is scope for epidemiological studies in developing countries. However, the International Program on Chemical Safety has created a harmonized poisons center call database (Intox) to try to improve data collection across the world.

Recording death as a result of poisoning is not easy because most deaths occur outside hospitals, and more than one toxin may be involved. Even when a toxicological laboratory analysis is performed, only requested substances will be identified. Comparative epidemiology of death by poisoning between different countries is made difficult by differences in the way deaths are investigated, certified, registered, and coded in different countries. The World Health Organization (WHO) has recommended the use of an additional "nature of injury" code, which identifies the mechanism or agent of injury and the intent. The International Classification of Disease (ICD) classification of drugs fails to distinguish between different antidepressant drugs or between heroin and methadone. Deaths registered since January 2001 in England and Wales have been coded to ICD-10, which makes it easier to identify total deaths from drugs of abuse, but the breakdown by type of drug is difficult if only the underlying cause of death is available. Deaths due to carbon monoxide or barbiturates have markedly decreased in the UK over the last 35 years. The number of suicides due to poisons has decreased in recent years in the UK but the total number of suicides remains stable.

In the USA poisoning deaths are recorded by at least two systems: US poisons control centers as reported by the TESS and the National Center for Health Statistics (NCHS). Deaths reported in TESS represent 5% of the poisoning deaths tabulated by NCHS. The concern is that differences observed in the two data sets may lead to differing health policies to address poisoning hazards. For example, cases may not be reported to poison control centers when the death occurred before arrival at hospital or after recognition as a poisoning during an autopsy. Reporting to poison control centers by the public and healthcare professionals is voluntary and a poison control center's participation in TESS is also voluntary. Nevertheless, TESS provides a valuable complement to NCHS data because of the timeliness of reporting, the attempts to integrate clinical information and autopsy findings, its value for detecting sentinel

events, and the ability to study specific trends. Shortcomings of the NCHS data set are that information available to medical certifiers is often incomplete. The overall rate of agreement on the ICD-9 code for the underlying cause of death in the death certificate with the ICD-9 code after autopsy was 71%, and there was disagreement about the cause of death in one-third of cases, which reflects difficulties of diagnosis *in vivo* as well as differences in product details. The ICD-9 coding system used by NCHS does not have the same level of product detail as the coding system used in TESS, thereby preventing the identification of specific drugs and chemicals involved in poisoning deaths. The potential for coding errors at the point of origin exists in both data sets.

The WHO/Euro Multicenter Project on parasuicide monitors trends in the epidemiology of suicide attempts across 13 European countries. The highest average male age-standardized rate of suicide attempts was found for Helsinki, Finland (314/100 000) and the lowest rate (45/100 000) was for Guipuzcoa, Spain. The highest average female age-standardized rate was found in Cergy-Pontoise, France (462/100 000) and the lowest rate (69/100 000) was for Guipuzcoa, Spain. With only one exception (Helsinki), suicide attempt rates were higher among women than men. In most centers, the highest rates were found in younger age groups. More than 50% made more than one attempt, and 20% of second attempts were made within 12 months of the first attempt. Compared with the general population, those who attempted parasuicide more often belonged to the social categories associated with social destabilization and poverty.

Self-Poisoning with Analgesics

Demography of Overdose with Analgesics

TESS data show that in adults over the age of 19 years analgesics such as indometacin, aspirin, and acetaminophen (paracetamol) are commonly taken in overdose in the USA. Acetaminophen and ibuprofen are most commonly ingested in overdose by children under the age of 6 years. Aspirin, aspirin combinations, and acetaminophen combinations are rarely ingested in childhood, which presumably reflects reduced availability to this age group because of Reye's syndrome for aspirin and the opioid component of acetaminophen.

Outcome Data for all Analgesic Overdoses

The majority of calls made to US poisons centers about analgesics refer to acetaminophen or nonsteroidal antiinflammatory drugs (NSAIDs: ibuprofen and indometacin), and that aspirin forms the minority of analgesics calls. Most patients have no sequelae after exposure to any analgesic, and 10–20% of those exposed have only minor sequelae, e.g., nausea. Aspirin is one to three times as likely as acetaminophen or NSAIDs to cause mild or moderate sequelae. The rate of major sequelae in aspirin poisoning is approximately the same as in acetaminophen poisoning. The rate of major sequelae in NSAID poisoning (ibuprofen and indometacin data combined) is approximately a third of that of acetaminophen. The major limitation in analysis of the data is the TESS definition of what constitutes minor, moderate, or major outcomes and this is particularly difficult to assess over a telephone, since such effects have a variable time course and are altered by treatment; for example, N-acetylcysteine use is associated with nausea and flushing in some patients. Thus such data can only give an overview.

The death rate for aspirin, both as a percentage of those treated and as a percentage of those exposed, is slightly higher than acetaminophen and the death rate for NSAIDs is about 10-fold lower. These death rates reflect deaths where the analgesic was declared to have been taken – it is not necessarily the cause of death in the patient. In many cases no analytical confirmation of toxin ingested was undertaken.

Acetaminophen Overdose

The main feature of untreated acetaminophen poisoning is hepatotoxicity. Comparative data worldwide on acetaminophen poisoning are remarkably difficult to obtain and it is very difficult making comparisons between countries because poisons centers' functions are different. From telephone call data to poisons centers it appears that 0.02–0.04% of each country's population take acetaminophen in overdose each year. This presumably reflects its widespread availability (e.g., 3.2 thousand million tablets are sold every year in the UK, that is, about 50 tablets per head).

A total of 0.02% of the Australian population and 0.08% of the UK population require admission or assessment at a healthcare facility each year because of acetaminophen poisoning. This is larger than the 0.01% of Americans accessing healthcare and could either reflect differences in access to hospital because of nationalized health services in Australia and the UK, or point to a smaller problem in the USA.

The first cases of liver failure due to acetaminophen were reported in 1966. Definitions of acute liver failure now vary worldwide and may depend on treating physicians. ICD-10-AM coding of acute liver failure is helpful but, due to expansion of codes from the

former ICD9-CM to ICD-10-AM more recently, acute liver failure episodes are difficult to distinguish in data from the USA, UK, and Australia from chronic liver failure. In addition, it should be remembered that the ICD-10-AM code is not used purely for acetaminophen poisoning and it may not be due to acetaminophen alone. Acetaminophen is the commonest cause of acute liver failure in the USA and in the UK. Acetaminophen-induced acute liver failure occurs in 0.6% of hospital episodes in Australia, and the same is true for the UK. In contrast, a "major" outcome (including acute liver failure and other major events) is reported for 1.5% of exposures and 3.5% of admissions in the USA. It is possible that the incidence of acetaminophen-induced acute liver failure is higher in the USA than in other countries, but the 3.5% figure may be skewed because of more difficult access to healthcare in the USA, and the "major outcome" data are not subdivided into acute liver failure and other events. In addition, individual patients' risk factors for acetaminophen poisoning are not assessed in any of the data sources and can give rise to differences in data, although in this respect it may be expected that the genetics of the population and alcohol use would be similar between, for example, Australia and the UK.

In all, 99.6% of admissions with acetaminophen poisoning survived according to the AIHW (Australian Institute of Health and Welfare) data; 0.4% died. This compares to USA data of 0.4% of admissions to healthcare facilities, recorded through TESS. More detailed information is available on 47 deaths due to acetaminophen poisoning in the USA from TESS in 2001: 32 were due to "acute," two due to "acute on chronic," and 12 due to chronic overdoses. All deaths were in adults over 17 years of age, except for one death of a 3-year-old.

Acetaminophen is a common poison in some regions of the developing world. Cases of hepatotoxicity have been reported from Bahrain, Chile, Hong Kong, Israel, Kuwait, Malaysia, Singapore, South Africa, and Taiwan.

"Accidental" versus "Deliberate" Acetaminophen Overdoses

An accidental overdose is one with no overt suicidal intent. The USA reports a different pattern of overdoses from that experienced in the UK, Denmark, or Australia; most US overdoses are reported as "unintentional." This may be a real phenomenon or may reflect idiosyncrasies of different healthcare systems.

Lee and coworkers reviewed cases of "acute liver failure" admitted to 17 academic units in the USA from January 1998 to October 2000 and reported 60% as "accidental" overdoses; acetaminophen was the most frequent cause of acute liver failure (98/258 = 38% of cases). TESS data support this view, suggesting 36 259 unintentional overdoses per year of acetaminophen alone compared with 19 443 intentional ones. In contrast, all acetaminophen calls made to the National Poisons Information Service in the UK were collected over a 14-week period ($n = 280$ calls). Only 19 were "accidental;" all of these were staggered overdoses; 17 received treatment with N-acetylcysteine. Five developed "hepatotoxicity" but all alanine and aspartate transaminase and international normalized ratio abnormalities resolved within 24–48 h, and none developed acute liver failure.

In the UK it is estimated that acetaminophen ± ethanol still accounts for 100–200 deaths annually. Whilst many patients may die relatively quickly due to opioid co-ingestion, death at home from acetaminophen poisoning alone is very unusual. Most acetaminophen-alone deaths occur in hospital from liver failure. Hence, acetaminophen poisoning is the largest cause of death from acute poisoning in hospital, despite the availability of an effective antidote if the overdose has occurred in the previous 12 h, and advances in the treatment of liver failure. The steep rise in dextropropoxyphene-related deaths between 1969 and 1979 prompted the introduction of blister packaging for acetaminophen/dextropropxyphene products. Whilst this probably arrested the sharp increase in deaths, the trend is still upwards in the UK.

Aspirin Overdose

In the UK, in 1985, 22.7% of analgesic overdoses were due to aspirin, but its use in overdose declined to 10.6% in 1997. Salicylate or aspirin poisoning is much less common than 20 years ago but, because of this, doctors may fail to recognize its severity or treat such patients optimally. American TESS data report 27 deaths in 2000 due to aspirin in patients between 15 and 88 years of age. One was due to chronic use, one unknown, and 25 were acute overdoses. One was reported as unintentional and the rest "suicide," with plasma concentrations between 40 and 1450 mg l^{-1} and timing uncertain.

NSAID Overdose

Ibuprofen is very commonly taken in overdose, as the TESS data show. Overdose by most NSAIDs causes little more than mild gastrointestinal upset, including mild abdominal pain. Vomiting and diarrhea may occur and 10–20% may have convulsions. Serious features include coma, prolonged fits, apnea, and bradycardia, but are very rare. Deaths have been reported after massive overdose of ibuprofen, but none so far with mefenamic acid.

Self-Poisoning with Antidepressants

In New Zealand, as in western Europe and North America and Australasia, antidepressant medications remain amongst the commonest classes of drugs taken alone or in combination. An important trend is the increasing use of selective serotonin reuptake inhibitors (SSRIs), and the newer antidepressants are associated with <10% of the risk of death than the older antidepressants. There is a strong association between area deprivation and deaths from antidepressants. Self-poisoning with antidepressants is common in urban areas throughout the tropics, but carries low mortality.

Self-Poisoning with Anxiolytic and Sedative Drugs

Self-poisoning with benzodiazepines is common in urban areas throughout the tropics, western Europe, and North America, but when taken alone carries a low mortality.

Sedative drugs are a common cause of fatal poisoning in the UK. The fatal toxicity index (FTI) is calculated by dividing the number of deaths (in England, Scotland, and Wales in this study) by the total number of prescriptions for the drug. For benzodiazepine anxiolytics the FTI was 3.0. In contrast, chloral hydrate carried an FTI of 46.5 and barbiturates 146. Whilst FTIs largely reflect the inherent toxicity of the drug in question, it is not possible to exclude from the coroner's data used in the calculations that the drug is more frequently taken, or prescribed for or taken in overdose by an at-risk group. Similarly, individual patient variables may alter the risk of poisoning, such as age, gender, other medical conditions, and whether the drugs were prescribed for drug dependence, psychiatric illness, or other indications. Alcohol potentiates the sedative effects of these drugs and these patients also have a disproportionately higher risk of suicide or accidental poisoning, both of which may increase the FTI for these drugs.

There was a marked decline in deaths due to high-toxicity drugs such as barbiturates, chloral hydrate, and betaine between 1983 and 1992 in the UK, with only small further reductions since. The reduction in deaths due to barbiturates directly followed reduced frequency of prescriptions. In contrast, reduction in deaths due to benzodiazepines coincided with a major reduction in prescription of temazepam gelatin capsule preparations in January 1996, showing there is scope for reducing sedative drug overdose mortality if they are being deliberately misused.

In Finland, the rate of psychotropic and sedative drug-poisoning admissions increased from 35% to 47% during the 1980s. In Poland, almost 25% of drug poisoning reported to the poisons center was due to sedative and to psychotropic drugs.

In Tehran, Iran, drugs were the most common cause of intoxication (60.2%). Of these, benzodiazepines (24.5%) were the most frequent.

Self-Poisoning with Antimalarials

Chloroquine poisoning is prevalent in Africa and the Pacific region and is often fatal. Chloroquine is the most common cause of pharmaceutical poisoning admission at referral hospitals in Zimbabwe. It is most often taken deliberately, especially in women who are pregnant. Quinine is a recognized drug used for self-harm in Europe. Cases have been seen in Casablanca, Morocco, and Thailand.

Drugs of Abuse

Defining drug abuse-related poisoning episodes and deaths is not easy. The EMCDDA (European Monitoring Centre for Drugs and Drug Addiction) has defined a standard list of ICD-9 codes for comparison of drug abuse-related mortality across Europe, but only counts deaths certified as due to a single substance, explicitly certified as "drug abuse/dependence." Thus, deaths due to other drugs that are often abused, such as cocaine and temazepam, are excluded if drug dependence/abuse was not written on the death certificate. EMCDDA data for England and Wales showed that deaths due to drugs of abuse increased from 140 per year in 1979–1981 to 568 in 1999. The Office for National Statistics (ONS) poisons-related deaths data in England and Wales show that deaths involving heroin and morphine, recorded on the death certificate, have risen steadily since 1993 in the UK and, if this trend continues, and deaths from carbon monoxide continue to fall, heroin will shortly be expected to be the leading cause of death by poisoning in England and Wales. Deaths involving methadone in England and Wales peaked in 1997 at 421 and have since fallen, presumably due to measures to limit the leakage of methadone from those to whom its is prescribed into the community, for example, pharmacy-supervised ingestion. Other controlled drugs account for relatively few deaths. In England and Wales, deaths due to amphetamines (including ecstasy) rose from 11 to 28 annually between 1993 and 1999.

Heroin and/or morphine dominated as a cause of fatal poisonings in Norway and Sweden. In Denmark, heroin and/or morphine caused about half of the fatal poisonings only, and nearly one-third of the fatal poisonings were caused by methadone. Except

for two cases in Sweden, methadone deaths were not seen in the other Nordic countries. Amphetamine caused one-tenth of the fatal poisonings in Sweden. In Finland only one-tenth of the deaths were caused by heroin and/or morphine and more by codeine and ethylmorphine. In Taiwan, amphetamines are the most frequently ingested poisons.

Self-Poisoning with Volatile Substances

Volatile substance abuse is the largest single cause of death in males aged 14–18 years after road traffic accidents in the UK and accounts for 20% of the deaths in men aged 20–29 years. It is not frequently encountered in the tropics.

Carbon Monoxide

The decline in fatal carbon monoxide poisoning in England and Wales from a peak in the early 1960s has been attributed to the replacement of coal gas with natural gas. This measure reduced both accidental and suicidal poisoning by a particular agent without a corresponding increase in suicide by other means.

In Turkey carbon monoxide deaths represent 27% of all poisoning fatalities. A 5-year (1997–2001) study of carbon monoxide poisoning in France showed domestic source was the commonest, with vented gas heating systems, mobile heaters, and thermal motors being the commonest sources.

Pesticide Poisoning

Pesticides are the most important poison used for self-harm throughout the tropics, being both common and associated with high mortality, and represent a major developing-world public health problem. It is deliberate self-poisoning that causes the majority of deaths rather than occupational exposure.

A recent study in Bangladesh showed 14% of all deaths amongst women aged 10–50 years were due to poisoning, mostly pesticides. Organochlorine compounds were the main cause of death (51.6%), followed by organophosphorous compounds (37.7%); however the trend is toward replacement of organochlorines with organophosphates. Poisoning with organochlorines has recently become an important cause of unremitting seizures in parts of South Asia. Poisoning is common in young children as they explore the environment with their mouths but as the dose ingested is seldom significant, the mortality rate is low.

Organophosphate pesticides were responsible for the majority of deaths in most self-poisoning cases in the developing world, particularly from rural areas, and the fatality rate is as high as 46% in some series. The fatality rate in Sri Lanka is 21.8%. In Sri Lanka in 1995–1996 organophosphate poisoning occupied 41% of the hospital's medical intensive care beds. Carbamate poisoning is widely reported in Brazil, Israel, and Jordan and after ingestion of rodenticides. The most common cause of fatal poisoning in Turkey between 1996 and 2000 was insecticides (43%). Among the insecticides, the organophosphates comprised 78%. Drug-related deaths were very rare.

Aluminum phosphide has recently become the commonest means of self-poisoning in Northern India, with a 61% mortality rate. It is particularly common in 11–15-year-olds.

Nearly 50% of all calls to the poison center in Malaysia related to pesticide poisoning. Pyrethroids were a common source of calls to a poisons center in India.

Where toxicity is well-recognized by the community, paradoxical increases in the rate of poisoning have occurred. Self-harm practices have grown around dimethoate in Zimbabwe, paraquat in Trinidad, Samoa and Fiji, malathion in Guyana, and parathion in Thailand. Compared with the last survey of poisoning in Zimbabwe, the pattern of poisoning at referral hospitals has changed over the last decade, with an increase in pesticide and pharmaceutical cases and a marked fall in cases of traditional medicine poisoning. Organophosphate poisoning is increasing rapidly in Zimbabwe. In Japan, the most frequent cause of poisoning was paraquat with a mortality of 76%. The second most frequent cause was organophosphate/carbamates with a mortality of 24%. When these two pesticides are excluded the mortality was only 3%.

Although there continues to be concern about possible toxicity from environmental and occupational exposure to pesticides in the UK, such compounds are responsible for fewer than 1% of deaths from acute poisoning in England and Wales.

Domestic and Industrial Chemicals

These are responsible for significant numbers of deaths and long-term disabilities worldwide. Domestic chemical poisoning is a major problem in African and Asian communities. Agents that are commonly involved include kerosene (in up to 68% of cases), Dettol (chloroxylenol), sulfuric acid, and bleach. The commonest age group involved is under 6 years and such products are often kept in nonchild-resistant containers. Poisoning was commoner among the lower socioeconomic classes and in males. In Ile-Ife, Nigeria, kerosene was the commonest agent, accounting for

40.9% of all cases; followed by caustic soda (20.4%) and traditional mixtures (19.7%). Oral administration of palm oil is the commonest home remedy. Morbidity was commonest with caustic soda, while a traditional mixture was responsible for 80% of all mortality. Paint thinners were commonly ingested in Delhi, India. Kerosene, pesticides, and medicinal substances remain the commonest agents associated with poisoning in Malaysia.

However, in Hong Kong adults largely take domestic products with the intention of self-harm. Deaths were due to aspiration of Dettol or detergent, or ingestion of sulfuric acid. Potassium permanganate is a common household disinfectant that has been used for self-harm in Hong Kong with fatal hepatorenal complications. Self-poisoning with hydrochloric or sulfuric acid is a major problem in Taiwan, with a 12% case fatality rate. Formic and acetic acids are used in rubber manufacture and self-poisoning with these agents is a problem in rubber plantation regions such as India and Sri Lanka and carries 30% mortality. Car battery acid poisoning was reported in Cape Town, South Africa, with fatalities.

Copper sulfate is widely used for self-harm in Southeast Asia. Death results in 25% of cases from hepatorenal failure, hemolysis, and gastrointestinal hemorrhage. In Seoul, South Korea, potassium cyanide represented 62% of all suicides from poisoning. Reports of cyanide self-poisoning have also been seen from India and Taiwan. Other chemicals that have been used for self-poisoning include turpentine, chromic acid, and ethylene bromide in India; sodium chlorite, ferric chloride, and methylene chloride in Taiwan; xylene in Jordan; and arsenic and cyanide in Zimbabwe.

Alcohols

Alcohol is second only to drugs for frequency of poisoning in Poland. It is also very common in Russia.

Plants

Plant poisoning is globally uncommon but locally popular in some areas. For example, in Sri Lanka there are thousands of cases each year of yellow oleander (*Thevetia peruviana*) poisoning and it causes 4.1% of deaths due to poisoning. Ingestion of oduvan (*Clistanthus collinus*) is a common self-harm practice in India. *Datura strammonium* poisoning has been reported in the tropics and is increasing in prevalence in the West because of the known hallucinogenic properties. In India, plant poisoning accounts for 1.5% of calls to a poisons center; *Datura* is the most commonly ingested plant being reported.

Herbal or Traditional Medicines

Traditional medicines are a common cause of accidental poisoning, but a rare cause of intentional self-poisoning. In South Africa, a study of 1306 cases of poisoning found 16% of admissions were due to traditional remedies but carried a mortality rate of 15%. Nonspecific effects, including vomiting, abdominal pains, and diarrhea, were most commonly encountered. A large proportion of patients also suffered from hematuria and dysuria.

Chinese medicines have been reported to be commonly used for self-poisoning in Hong Kong and Taiwan and are an increasing problem in the UK.

Rare Poisons

Thallium-containing rodenticides were banned in the USA during the 1960s, but they are still used in some tropical countries. Deliberate self-poisoning has been reported in Mexico and Thailand. All but two of 50 patients in the Mexican series made a full recovery. Of 19 patients poisoned with avermectin in Taiwan, seven showed significant signs of toxicity and one died.

Long-acting "superwarfarin" compounds such as brodifacoum cause long-term coagulopathies and have been used for self-poisoning in Hong Kong. Dapsone is a common cause of accidental poisoning in children in India, but not worldwide.

Poisoning by cosmetic products is rarely serious but 46 cases of hair dye (paraphenylenediamine) poisoning resulted in 12 deaths in Khartoum, Sudan, and Casablanca, Morocco.

Possible Interventions to Change the Epidemiology of Poisoning

Availability

Banning common poisons, such as pesticides, may be effective in particular regions. Improved storage of pesticides and medicines may also reduce the incidence of poisoning. However, locking pesticides away safely is difficult in rural areas where farmers live in huts without beds, furniture, or cupboards. While it may be possible to ban the more toxic pesticides and replace them with safer ones, safer pesticides are expensive and therefore unaffordable in the developing world. Banning some pesticides has led to the adoption of other, equally dangerous ones.

Pack-Size Restrictions

There are some UK data to support efficacy of legislation on pack sizes. Hawton and coworkers showed

that the annual number of deaths from acetaminophen poisoning decreased by 21% (confidence interval 5–34%) after legislation. Liver transplant rates decreased by 66% (55–74%) and the rate of acetaminophen overdosage decreased by 11% (5–16%). The average number of tablets taken in overdose decreased by 7% (0–12%). However, the mean blood concentration of acetaminophen did not change. Corresponding data for aspirin showed that the annual number of deaths from salicylate poisoning decreased by 48% (11–70%) but the average number of tablets taken did not decrease. Irish data on 2020 cases suggest no impact from a voluntary scheme of restriction in pack size and Scottish data are similarly negative. Whilst the incidence of acute liver failure is falling, this may reflect the absolute incidence falling but the ratio of acetaminophen to acute liver failure may be the same.

Packaging

Every encouragement should be given to manufacturers to provide better labeling and packaging of potentially harmful products, if necessary by legislation, but there is a need for industry to be self-regulating. The packaging should not require the user to have a PhD in chemistry or toxicology to understand the information provided. Because of the inconvenience and longer time required to punch out the tablets, strip packaging may reduce the number of tablets that can be readily swallowed by adults with self-poisoning and studies have shown that large overdoses were mainly from loose tablets.

As a result of child-resistant closures, a greater emphasis on safety in the home, improved access to poisons information, improved management, and the introduction of blister packaging, fatal poisoning in children less than 10 years of age is now rare in some countries such as the UK.

Dilution of Products

To reduce instances of paraquat/diquat poisoning, for example in Japan, dilution of the available product or formulation in other than liquid form would be desirable.

Putting an Antidote, e.g., Methionine, into Acetaminophen Tablets?

Methionine is an effective antidote in acetaminophen poisoning. However, if used as a prophylactic it would need to be put in all acetaminophen tablets to be effective. Methionine metabolizes to homocysteine, which is an independent risk factor for CAD (coronary artery disease) and stroke. There was therefore concern that regular acetaminophen and methionine use may induce hyperhomocysteinemia. However, a recent study with 16 volunteers demonstrated no difference in endothelial-dependent vascular responses after acute (250 mg methionine orally) 1 month of 250 mg per day or 1 week of 100 mg kg^{-1} g per day, although a 1-week regime significantly increased plasma homocysteine concentrations. Other concerns around methionine are that it is a carcinogen, and may reduce serum folate, and hence is of concern in pregnancy. Inconveniences are that combination tablets have a fishy taste and cost eight times more than standard acetaminophen tablets.

Banning Drugs

During criminal extortion of a company making acetaminophen in Australia, where a batch had been contaminated with strychnine and all acetaminophen products were then removed from over-the-counter sales, a switch to therapeutic use of aspirin and NSAIDs took place. There was a concurrent significant increase in accidental ibuprofen overdoses and increase in deliberate aspirin overdoses. A switch to aspirin may claim excessive deaths in overdoses and increased adverse effects from therapeutic use. A switch to NSAIDs would not be expected to increase death from overdose, but again would be expected to result in increased adverse effects from therapeutic use.

Making Certain Drugs Prescription-Only

There are no data to support a view that removing, for example, acetaminophen or aspirin from over-the-counter use would necessarily limit the number of overdoses, since significant overdose with prescription-only products occurs, such as tricyclic antidepressants. Australian data showed that, during the acetaminophen extortion, when acetaminophen became prescription-only, there was a substantial cost/time resource perspective for prescriptions.

Monitoring Use of Drugs

As more medicines become available over-the-counter, healthcare professionals have less control over use. It is important therefore that some control is maintained. Better monitoring will be needed in terms of adverse therapeutic events and overdose and increased collaboration with pharmacists will be needed, together with better databases for recording information. Surveillance work is important in identifying problems and allowing appropriate remedial action to be taken as new products emerge or changes in packaging or sales affect the incidence of poisoning by certain products. The poisons centers of each country should form an important part of this work.

Improved Care of Poisoned Patients

Lack of evidence-based guidelines, lack of resources such as drugs, intensive therapy unit facilities, and staff are key variables altering outcome in poisoning.

Striking at the Core of the Problem

The practice of deliberate self-harm is open to programs to reduce its incidence. Such interventions to prevent recurrence of self-harm behavior might include postcards from the edge, education in schools, and increased availability of counseling.

Conclusions

There are no agreed best-practice guidelines to govern collection of toxicology data worldwide and these require to be developed. The prevalence of drug-related hospital admissions in North America and western Europe point to preventive strategies to decrease the availability of toxic doses of drugs (including illicit drugs) for ingestion as the key to reducing hospital admissions for poisoning. Measures to reduce carbon monoxide deaths still further need to be employed. In less well-developed countries, support is needed to develop effective prevention and medical management strategies and resources, to deal with pesticide and household poisoning in particular. The efficacy of any intervention can only be assessed if adequate methods of recording data are employed. There remains an enormous challenge to reduce the incidence, morbidity, and mortality of poisoning worldwide.

See Also

Alcohol: Acute and Chronic Use, Postmortem Findings; **Deliberate Self-Harm, Patterns**; **Drug-Induced Injury, Accidental and Iatrogenic**; **History of Toxicology**; **Internet:** Toxicology; **Pharmacology of Legal and Illicit Drugs**

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