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Case report

Two UK suicides using nicotine extracted from tobacco employing instructions available on the Internet

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ABSTRACT

Tobacco is one of the most easily accessible and commonly abused drugs world-wide. Nicotine, one of its principal constituents, can cause serious or fatal overdoses. Whilst the deliberate ingestion of this substance appears to be relatively rare, often the important signs of its consumption are not recognised, sometimes with fatal results. Here we describe two cases of intentional fatal ingestion of nicotine. The nicotine was extracted from tobacco using instructions available on the Internet. The first case involved a male aged 19 who died in 2008. The post-mortem blood and urine levels of nicotine were 5.5 mg/l and >80 mg/l respectively; the blood level is in line with the generally recognised fatal level of >5 mg/l. The levels of nicotine's main metabolite, cotinine, for this case were 2.5 mg/l and 7.9 mg/l for blood and urine respectively. A comparative case in 1999 involved a 32 year-old male. The level of post-mortem nicotine in his blood was 1.0 mg/l. These are believed to be the first UK suicides by nicotine using instructions from the Internet reported in the literature. Information that nicotine was the agent responsible only became apparent some time after death. There may be more deaths due to this cause that go unrecognised because quantification of nicotine and cotinine levels is not often conducted, due to the wide prevalence of smoking. It is important that all evidence at the scene of a sudden and unexplained death is carefully evaluated, including potential clues on PCs and lap-tops.

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1. Introduction

Nicotine is a water-soluble alkaloid present in the leaves of the plant *Nicotiana tabacum* L.; this substance is highly toxic and has strong addictive potential. The leaves of tobacco are dried, shredded, and sold as snuff, chewing tobacco, cigarettes, cigars and pipe tobacco. Nicotine itself is available in a range of products aimed at individuals trying to stop smoking and used in insecticides. The nicotine content of a tobacco leaf is 0.5–8.0% [1]; that of cigarettes is normally 10–20 mg/g of tobacco.

Nicotine is rapidly absorbed in human beings through the skin, alveoli, or pharyngeal mucous membranes, and the gastrointestinal mucosa. Peak plasma concentrations after oral administration of nicotine occur about 60 min after ingestion [2]. The plasma half-

life of nicotine is 100–200 min but that of its metabolite cotinine is 770–1185 min [3–5].

When nicotine overdose occurs, gastrointestinal symptoms appear within a few minutes: nausea, vomiting, and diarrhoea. Systemic effects include: agitation, headache, sweating; auditory and visual disturbances, confusion, increased blood pressure, bradycardia, and tachycardia [6,7]. If the poisoning is severe, dyspnoea, cyanosis and coma are apparent also [8]. Death can occur within the space of a few minutes but usually within an hour of ingestion [9]. Death is typically due to paralysis of the respiratory muscles [1,10,11], but may be caused by cardiovascular collapse [9]. Despite the fact that nicotine usually triggers an emetic response, this is not always the case.

The quantity of nicotine considered lethal for children is 10 mg [12]; the level for adults is 40–60 mg (0.5–1.0 mg/kg body weight). Deaths have been reported from the ingestion of 30 g tobacco, the infusion of 15–20 g of tobacco, an enema of 8 g of tobacco, and 0.8 g of snuff [13]. Two to four drops (23–33 mg per drop) of pure nicotine can prove lethal.

Serious or lethal overdoses of this substance appear to be relatively rare. Nicotine-related fatalities have occurred from a

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variety of causes: ingestion of salads containing wild tobacco leaves; boiled tobacco water enemas for intestinal parasites; ingestion of concentrated nicotine-based pesticide formulations; administration of multiple nicotine transdermal patches; oral ingestion of tobacco eluate (concentrate); smoking cigarettes containing crystals of nicotine tartrate; and nicotine solution mixed with alcohol.

2. Nicotine-related fatalities in the UK

Published information on nicotine-related fatalities in the United Kingdom (UK) has not been collated systematically. The first reported nicotine-related death in the UK occurred in 1854 [14]. Between then and 1958, at least 22 cases were reported in national and local newspapers as well as medical journals, including the British Medical Journal and The Lancet. In none of these cases were blood levels detailed; in some instances the route of administration and the source of the nicotine are not given. Where known, five deaths followed the swallowing of nicotine insecticide solutions, 11 from swallowing tobacco or tobacco products (including two infants using old tobacco pipes as playthings), two young teenagers and one pensioner from 'excessive smoking', and one from the application of tobacco juice to a child's head to cure ring-worm. At least five were suicide, together with one further probable suicide; most appear to have been accidental. Clarke [15] reported that there were 103 nicotine poisoning deaths in England and Wales in 1948–1957, noting a further 20 in 1958–1961 [16]. Five accidental fatalities of children aged less than 10 years caused by nicotine poisoning occurred in 1958–1977 [17]. More detailed statistical information is held by the national General Mortality Registers but poisoning mortality statistics are no longer published in sufficient detail to facilitate the identification of cases in the last two decades.

The National Programme on Substance Abuse Deaths (np-SAD) was established after the Home Office Addicts Index closed in 1997 and, since then, it has regularly received information from coroners on a voluntary basis on deaths related to drugs in both addicts and non-addicts in England and Wales, Northern Ireland, the Channel Islands and the Isle of Man. Since 2004, information has been received from the Scottish Crime and Drug Enforcement Agency and the General Register Office for Northern Ireland. To date, details of some 21,000 deaths have been received. To be recorded in the np-SAD database as a drug-related death, at least one of the following criteria must be met: (a) presence of one or more psychoactive substances directly implicated in death; (b) history of dependence or abuse of drugs; and (c) presence of controlled drugs at post-mortem. The response rate from coroners in England and Wales has been as high as 95% [18].

Here we present two case reports of suicide by nicotine extracted from tobacco. The 2008 case was identified through routine data collection at West London coroner's court. A search of the Internet for any similar deaths (using the search terms 'nicotine', 'tobacco', and 'suicide') led to the identification of the 1999 case through media reports [19,20]. Liaison with the coroner's office in Powys resulted in details of the case being submitted to the np-SAD. Although the cases described here do not fall within the usual criteria for the Programme's case definition, it is felt that these are sufficiently unusual that they merit publication.

3. Case reports

3.1. Case 1

In 2008, a 19-year-old single white male student (height 181 cm, weight 51 kg) was found dead by his father when he

entered his son's bedroom. The decedent was laying naked, face-down, beside the bed. His body exhibited hypostasis, and appeared to have been dead for several hours. There was evidence of brownish-yellow vomitus on the body and the bed, together with large quantities of faeces on the bed and the body. There were several empty carbonated drink bottles beside the body; they were stained with a brown residue. Tobacco residue and empty tobacco packets were found. A saucepan covered with metal foil and containing a brown sticky treacle-like substance was found beside the deceased's personal computer (PC). The room was very untidy; this was not unusual for this individual. Police attended but there were no suspicious circumstances.

The cause of death was not immediately apparent. The post-mortem, conducted 4 days after death, revealed nothing significant; the lungs were congested and oedematous with frothy oedemic fluid in the airways. The heart, lungs, liver, kidney, etc. were all normal. The deceased had no significant past medical history. However, he did have a past history of excessive alcohol consumption and regular cannabis use. About 14 months prior to death, the deceased had been discovered looking at an Internet website on how to arrange his own funeral. He was subsequently diagnosed with a possible schizophrenic or drug-induced psychosis.

Several days after the death, when tidying up his son's bedroom, the father turned on the PC and saw new icons on the desk-top. He looked in the 'recycle' bin and saw a text document called "death". This document contained information from an Internet site [21] giving many ways of committing suicide, including extraction of fatal doses of nicotine from tobacco. This is done by soaking 150 g of tobacco in water for several days and then simmering the liquid until it leaves a treacle-like residue. This residue is then "added to a night time drink and [you] never wake up". The significance of the empty tobacco packets, tobacco residue, the empty drink bottles, and the saucepan then became apparent.

Further special post-mortem toxicological analyses were therefore undertaken. Femoral blood samples were taken. The results were as follows: ethanol–blood 43 mg/100 ml, urine 87 mg/100 ml; nicotine–blood 5.52 mg/l, plasma 7.44 mg/l, urine >80 mg/l; cotinine–blood 2.52 mg/l, plasma 3.11 mg/l, urine 7.88 mg/l. The nicotine and cotinine levels were quantified by a validated gas chromatography assay using nitrogen phosphorous detection [22]. These levels of nicotine and its metabolite cotinine are regarded as lethal. No other common or illicit drugs were detected by a drug screen. The cause of death was recorded as nicotine toxicity. The coroner returned a verdict of suicide.

3.2. Case 2

In 1999, a 32-year-old single unemployed white male (height 168 cm, weight not given) was unable to be contacted by his parents who lived in a house across the street. His concerned mother entered his home, to find him dead, lying face-up, on the bathroom floor.

There was evidence of faeces in the bath (which was full of water), faeces on the floor and in the toilet. There was no sign of head injury but blood and saliva were on the floor near the head; the deceased's hair was wet. The post-mortem revealed that there was vomitus present in the nostrils and mouth. The stomach contained "about 400 ml of brown fluid with a fruity prune-like odour", some of which was present in the oesophagus, mouth, and main airways. The lungs were severely congested with petechial haemorrhages on the pleural surface. The brain and meninges were congested. Otherwise, there was nothing of note.

According to a 'suicide note' left on his PC, the decedent was concerned he was no longer capable of earning money. He stated that as he was typing the note he had taken a nicotine overdose,

Table 1
Summary of previously published toxicological findings for post-mortem human blood concentrations of nicotine for single dose, acute poisoning.

Reference	Case(s)	Source of nicotine	Route of exposure	Time between death and autopsy	Blood sample site	Toxicology findings
Møller et al. [25]	Male 45, chronic alcoholic, suicide	80% nicotine solution in port wine bought from pharmacy	Oral	<24 h	Not given	28 mg/l
Maehly et al. [26]	Average of 16 cases; 2 suicides, rest accidents	Not given	Not given	Not given	Not given	25.7 mg/l
Turner [27]	Average of 3 cases	Not known	Not known	Not given	Not known	28.5 mg/l
Grusz-Harday [28]	3 children (aged 6–10) and 19 adults (aged 27–69) suicides and accidents	Nicotine pesticide solution	All oral	Not given	Not given	Children: mean 96.67 mg/l (range 50–120 mg/l); adults: mean 530.7 mg/l (range 16–5800 mg/l); 52 mg/l (heart 10 mg%)
Tiess and Nagel [29]	Male 55, smoker and alcoholic	Nicotine solution	Oral	63 h	Average of heart/vein	6 mg/l
Krauland et al. [30]	Female 23 injected with 0.5 ml of 97% nicotine solution	Nicotine solution	Injected (medical procedure)	Not given	Not given	6 mg/l
Baselt et al. [31]	5 swallowing 20–25 g of nicotine sulphate	Nicotine solution	Oral	Not known	Not given	29 mg/l
Lavoie and Harris [32]	Male 17, suicide	Nicotine alkaloid pesticide solution	Oral	Not given	Not given	13.6 mg/l
Sims [33]	Male 54, injected	Not known	Injected	Not given	Sub-clavian	140 mg/l
Takayasu et al. [34]	Female 44, suicide	Tobacco eluate	Oral	Not given	Not known	6.3 mg/l
Kemp et al. [35]	Female 31, probable suicide	Multiple transdermal nicotine patches	Skin	Not given	Heart/femoral	Heart 1.4 mg/l, femoral 0.46 mg/l
Solarino et al. [36]	Male 46, suicide, +tramadol	25 transdermal nicotine patches and tobacco/nicotine solution	Skin and oral	Not given	Femoral	0.6 mg/l

and that its effects were beginning to overcome him. It appears that the deceased had obtained the recipe for the nicotine extract from the Internet. The probable source of the original information was “The Anarchist’s Cookbook”, although the website used by the deceased is no longer available (<http://dark-secrets.com/hack-ersecrets/abook/cookbook/nicotine.html>).

A jar containing a tar-like liquid was found in the kitchen. It was described as smelling like molasses, having a smell similar to that emanating from the deceased’s body at post-mortem. Tests on the jar’s contents revealed that it contained almost pure nicotine. Toxicological analysis using Thin Layer Chromatography of urine specimens from the deceased revealed only the presence of nicotine. Gas Chromatography with Mass Spectrometric detection revealed a post-mortem blood nicotine level of 1.0 mg/l; this was considered to be in the toxic range. No other common or illicit drugs were detected. The site(s) from which the blood samples were taken was not recorded in the autopsy or toxicology reports but is likely to have been from the femoral vein. The autopsy took place the day after the body was found. The length of time between death and autopsy was not recorded. The cause of death was recorded as nicotine poisoning. Recording a verdict of suicide, the coroner said he was surprised a recipe for poisoning could be obtained so easily, and was concerned about potential copycat incidents.

4. Discussion

Fatalities caused by nicotine are rare events, especially from the ingestion of tobacco extract. Rarer still are successful suicides employing this method; the emetic effects of nicotine often cause patients to vomit and thereby expel the toxic substance before it reaches lethal levels [5,10,23].

The levels of nicotine and cotinine recorded in the first case reported here (post-mortem blood 5.5 mg/l, plasma 7.4 mg/l, urine >80 mg/l; cotinine–blood 2.5 mg/l, plasma 3.1 mg/l, urine 7.9 mg/l) are several orders of magnitude higher than the average peak

levels for living smokers (at 0.03–0.35 mg/l and 0.25–0.34 mg/l respectively) [24]. The nicotine level (5.5 mg/l) in this case is at the lower end of the fatal range for blood concentrations (see Table 1), but the urine level is exceptionally high. There are no reports of single substance fatalities that give cotinine levels; however, those in this first case exceed those given in the case of a fatal poisoning by methomyl and nicotine [37], and a case involving fatal nicotine and tramadol poisoning [36]. The blood level of nicotine in the second case reported here (1.0 mg/l) is lower than the fatal levels given in other studies. Again, the nicotine levels are several orders of magnitude higher than the average peak levels for smokers. It should be noted that nicotine may exhibit post-mortem redistribution; heart/femoral blood concentrations of 2.7–3.0 have been reported in 2 deaths [35,38]. As peripheral blood, such as that from femoral veins, is less susceptible to post-mortem elevation in drug concentration seen in central blood sources (such as the heart), it is preferred for post-mortem analysis. It is not known if either of the decedents were smokers.

Intoxication and toxicity caused by tobacco extract is very easy to miss by physicians. The clinical signs of nicotinic poisoning may lend themselves to misinterpretation. Similarly, fatalities caused by ingestion (whether accidental or deliberate) of nicotine extracted from tobacco may be overlooked by those investigating sudden deaths with no apparent cause(s). Without the additional clues left by the deceased themselves, whether containers with treacle-like residues or documents or web-links on their computers, these two UK fatalities could have been recorded as ‘unascertainable’. The link between tobacco and nicotine poisoning was not immediately apparent. Due to the prevalence of smoking in society, the relevance of nicotine presence in a sample may be missed or overlooked and quantification may not form part of standard analytical protocols. If a nicotine overdose is suspected, the relevant analytes can be specifically targeted and quantified.

In previous decades information about how to prepare lethal formulations of nicotine was derived from oral tradition or printed sources. Saxena and Scheman [39] refer to examples such as the

recipe for nicotine concentrate given by Saxon [40]. The Internet has become of great significance as a source of information about suicide, including the facilitation of intentional self-killing, with websites concerned with the right to die, helping individuals choose a method for suicide, and obtaining lethal substances [41]. The website accessed by the first decedent is the same as that referred to by Schneider et al's [5] description of an attempted suicide using a recipe obtained from the Internet. "Cybersuicide" [42] by poisoning is not an easy phenomenon to prevent given: (a) ever-increasing accessibility to the Internet via PC, lap-top and the ubiquitous mobile telephone; and (b) the ease with which detailed technical information about suicide methods can be identified [43].

5. Conclusions

This paper has described what are believed to be the first two suicides in the UK by nicotine derived from tobacco using instructions available on the Internet reported in the scientific literature. Although unusual, other such deaths and unsuccessful attempts have been reported using this method, as well as other instances of poisoning by other tobacco products and nicotine pesticide solutions.

These cases have demonstrated that in sudden and unexpected deaths with an unknown cause, a thorough examination of the scene – including computers – can yield vital information where an unusual agent, such as tobacco or nicotine, may have been involved. Due to the widespread prevalence of smoking, and therefore the frequency with which nicotine is detected by toxicological screening, there is the potential for its significance to be overlooked when present in overdose.

Clinicians need to be aware of the patho-physiological presentations of patients who may have ingested tobacco since swift and aggressive treatment is required. It is particularly important to support respiratory function, protect the airway, and prevent cardiovascular collapse.

Conflict of interest

We are unaware of any conflict of interests.

Declaration

This work has not been previously published and has not been submitted for publication elsewhere. Publication is approved by all authors and the responsible authorities where the research was undertaken. If accepted, the paper will not be published elsewhere in the same form, in English or in any other language, without the written consent of the copy-right holder.

Contributors

John Corkery and Alessandro Vento undertook data collection and preparation. Jennifer Button was involved in the toxicological analysis of the first case-study. All four authors contributed to the writing of the paper.

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