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TOXICOLOGY INVESTIGATION

Presentations to the Emergency Department Following Cannabis use—a Multi-Centre Case Series from Ten European Countries

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Abstract Cannabis is the most commonly used illicit drug in Europe, and is generally regarded as having low acute toxicity. We present the findings of the first 6 months of data collection from the Euro-DEN project on presentations related to cannabis use to further understand the acute toxicity related to the use of cannabis. Data was extracted on clinical features, treatment and outcome from the Euro-DEN minimum dataset for all cases of acute recreational drug toxicity reported 1st October 2013 to 31st March 2014 for all cannabis-related presentations. Of 2198 presentations reported by 14 of the 16 Euro-DEN centres, 356 (16.2 %) involved cannabis either alone or together with other drugs/alcohol. There were 36 that involved lone use of cannabis (1.6 % of all presentations). Of the 35 non-fatal lone cannabis presentations, the most commonly reported features were neuro-behavioural (agitation/aggression 8 (22.9 %), psychosis 7 (20.0 %), anxiety 7 (20.0 %)) and vomiting 6 (17.1 %). Most patients (25, 71.4 %) received no treatment and 30 (85.7 %) were discharged/self-discharged from the ED. There was one fatality amongst these lone-cannabis cases: an 18-year-old male collapsed with an asystolic cardiac arrest whilst smoking cannabis and suffered hypoxic brain injury related to prolonged cardiac arrest. THC was detected in a urine sample taken at ED arrival; no other drugs were detected. Lone acute cannabis toxicity was typically associated with neuro-behavioural symptoms and vomiting. Although uncommon, severe toxicity including cardiovascular toxicity and death may be under-recognised, and it is important that Emergency Physicians are aware of this.

Keywords Cannabis · Acute toxicity · Emergency Department · Euro-DEN

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Introduction

Cannabis is the most commonly used illicit drug in Europe—an estimated 73.6 million Europeans (21.7 % of adults aged

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15–64 years) have used cannabis in their lifetime and 18.1 million (5.3 % of adults) have used cannabis in the last year [1]. Use is higher in young adults, with last year use of 11.2 % in those aged 15–24 years. There is variation in the patterns of use across Europe ranging from 0.4 % last year use in Romania to 9.6 % last year use in Spain [2].

There has been an increase in cannabis production in Europe in recent years, and this has been associated with increasing use of herbal cannabis and a decrease in cannabis resin use [3]. There is also variation in tetrahydrocannabinol (THC) content in cannabis both within and between countries across Europe. The potency of both herbal and resin has increased since 2006, with some evidence of increased availability and use of higher potency cannabis [1, 3].

Cannabis is generally regarded as having low acute toxicity [4], and given this perception of low toxicity, there have been few recent reports on the patterns of acute toxicity associated with cannabis use [5]. There have been some reports suggesting the potential for significant acute cardiac toxicity associated with cannabis use [6], but most recent reports have focused on specific acute adverse effects such as hyperemesis [7] or on the potential for chronic toxicity associated with long-term cannabis use [8].

The European Drug Emergencies Network (Euro-DEN) project is a European Commission funded project collecting data on Emergency Department (ED) presentations with acute toxicity related to the use of recreational drugs and novel psychoactive substances (NPS) [9]. We present the findings of the first 6 months of data collection on presentations related to cannabis use to further understand the acute toxicity related to the use of cannabis.

Methods

Using the Euro-DEN minimum dataset, centres taking part in the Euro-DEN project recorded self-reported recreational drugs used, demographic data, clinical features, treatment and outcome on an Excel® spreadsheet for all presentations of acute recreational drug toxicity [9]. Individual centres sent their completed data collection sheets to the Euro-DEN coordinating centre in London, UK. This retrospective data collection had appropriate ethics/data protection approval from all participating centres. The centres collecting this clinical dataset are in Denmark (Copenhagen), Estonia (Parnu/Tallinn), France (Paris), Germany (Munich), Ireland (Dublin and Drogheda), Norway (two centres in Oslo), Poland (Gdansk), Spain (Barcelona and Palma de Mallorca), Switzerland (Basel) and the UK (York, two centres in London).

The inclusion criteria for this study were all presentations in which there was self-reported use of cannabis (defined as cannabis, cannabinoids (*not* synthetic cannabinoids), marijuana, hashish, weed, skunk or THC) either alone or together with other drugs/alcohol from 1st October 2013 to 31st March 2014. These identified cases were extracted for further analysis using descriptive statistics in Excel®. Data are presented as percentages or median (IQR) as appropriate.

Results

Two thousand one hundred ninety-eight presentations were reported by 14 of the 16 Euro-DEN centres (data was not available for analysis from Copenhagen, Denmark and Dublin, Ireland), with 356 (16.2 %) involving cannabis. Of these 356 presentations, 36 involved lone-use of cannabis (1.6 % of all presentations and 10.1 % of the presentations involving cannabis). Table 1 shows the geographical breakdown of the presentations.

Demographics and Circumstances of use in the Cannabis Presentations

The majority of users were male (272; 76 %), and the median age of the users was 26 (20–33) years. Most users (274; 77 %) were resident in the city of the research centre, with 65 (18.3 %) living in another city in the same country and 15 (4.2 %) from other countries (the home location was not known/recorded in two (0.6 %) presentations). The location of cannabis use was not recorded or unknown in 169 (47.5 %) presentations; for those in which it was recorded, the location of use was at home (59; 16.6 %), on the street (56; 15.7 %), in a bar or nightclub (33; 9.3 %), in another private location (16; 4.5 %), in police custody (7; 2.0 %) and at a festival (2; 0.6 %).

Information on the route of use of cannabis was available in 267 (75.0 %) presentations. In the majority of these, cannabis was smoked (252; 94.4 %); it was taken orally in 15 (6.0 %) presentations. Information on type of cannabis used was available in 235 (66.0 %) presentations, and in the majority of these, it was described as herbal (188; 80.0 %), pre-prepared cigarette (14; 5.9 %) or unknown (11; 4.7 %); the distinction between plant and resin was not recorded.

Toxicological screening is not routinely carried out in all the Euro-DEN centres, but was conducted in 116 (32.6 %) of the presentations involving self-reported use of cannabis. In 103 (88.8 %) of these, cannabis (as THC) was detected in blood and/or urine samples. In four (3.4 %) presentations, a history of cannabis use was given, but it was not detected in blood or urine samples, and in nine (7.8 %) presentations, the presence/absence of cannabis was not specified in the screen results.

In the 320 (89.9 %) presentations in which cannabis was used with other drugs/alcohol, the most common substances used were as follows: alcohol in 190 (59.4 %), benzodiazepines in 73 (22.8 %) [clonazepam 15 (4.7 %); diazepam 11 (3.4 %); alprazolam 9 (2.8 %), unspecified benzodiazepine 33 (10.3 %); other benzodiazepines 5 (1.6 %)], cocaine in 58

Table 1 Number of presentations involving cannabis reported by the Euro-DEN centres (1st October 2013–31st March 2014)

City, country	Number of acute recreational drug toxicity presentations	Number of presentations involving cannabis (% of total)	Number of lone-cannabis presentations (% of all cannabis presentations)
Parnu, Estonia	8	2 (25 %)	0
Tallinn, Estonia	39	11 (28 %)	3 (27 %)
Paris, France	225	27 (12 %)	9 (33 %)
Munich, Germany	98	32 (33 %)	1 (3 %)
Drogheda, Ireland	23	11 (48 %)	3 (27 %)
Oslo Centre-1, Norway	637	66 (10 %)	0
Oslo Centre-2, Norway	76	14 (18 %)	0
Gdansk, Poland	76	12 (16 %)	3 (25 %)
Barcelona, Spain	99	27 (27 %)	2 (7 %)
Mallorca, Spain	66	18 (27 %)	1 (5 %)
Basel, Switzerland	93	33 (35 %)	0
London Centre-1, UK	463	53 (11 %)	5 (9 %)
London Centre-2, UK	196	37 (19 %)	4 (11 %)
York, UK	99	13 (13 %)	5 (38 %)
Total presentations	2198	356 (16 %)	36 (10 %)

(18.1 %) and amphetamine in 36 (11.2 %). In 22 presentations, cannabis was used together with an NPS; the most common NPS were mephedrone (7 presentations) and MDPV (2 presentations). There was one case in which cannabis was used together with a product potentially containing synthetic cannabinoid receptor agonists.

In order to describe the clinical picture of acute cannabis toxicity, the 36 lone-cannabis cases were focused on. The majority (27; 77.1 %) of these were male with median age 22 (20.0–26.5) years; there was one fatality amongst these cases, this will be described separately.

Non-Fatal Lone-Cannabis Cases

Twenty one (60.0 %) of these 35 patients came to the ED by ambulance. In 13 (37.1 %) presentations, the time of use was unknown or not recorded; in the cases in which this data was available, two (9.1 %) patients attended the ED within 1 h of using cannabis, 11 (50.0 %) between 1 and 4 h after use, five (22.7 %) between 5 and 12 h after use, one (4.5 %) 13–23 h after use, three (13.6 %) more than 24 h after use.

Table 2 summarises the initial observations measured on arrival in the ED; the majority of the patients were alert with normal heart rate and blood pressure on presentation. Table 3 summarises the frequency of the pre-determined clinical features that were reported in these 35 presentations.

Peak QRS and QTc were recorded in 10 presentations: peak QRS 94 (84–100) msec and peak QTc 411 (399–422) msec. Peak creatinine was measured in 10 presentations and was normal (87 (73–92) μmol/L).

Most (25; 71.4 %) patients received no treatment. Of the 10 patients that did receive treatment, this was most commonly sedation (in hospital only (five cases), both prior to and in hospital (one case)). In the majority of these, benzodiazepines (four cases) were used; olanzapine was used in two presentations and chlorprothixene and hydroxyzine in one presentation each. Of the eight patients with agitation and/or aggression, five received no sedation; one received benzodiazepines

Table 2 Presentation observations in the non-fatal lone-cannabis cases

Observation	Result			
	Number	Percentage	Median	Interquartile range (IQR)
Level of consciousness (Glasgow coma score (GCS))	32			
GCS 15/alert	27	84.3		
GCS 14	2	6.2		
GSC 13	2	6.2		
GCS 3	1	3.1		
Heart rate (bpm)	32		87	73–98
Systolic BP (mmHg)	29		132	118–136
Diastolic BP (mmHg)	29		76	67–88
Temperature (°C)	29		36.3	36–36.7
Respiratory rate (per minute)	23		18	16–20
Blood glucose (mmol/L)	20		7.0	5.8–8.1
Lactate (mmol/L)	6		1.1	0.9–1.5

Table 3 Clinical features in the 35 non-fatal lone-cannabis cases

Clinical feature	Occurrence as the only clinical feature	Occurrence with other clinical features
Agitation/aggression	4	4
Psychosis	4	3
Anxiety	0	7
Vomiting	4	2
Chest pain	1	3
Palpitations	0	3
Hallucinations	0	3
Seizures	1	1
Hypertension	0	2
Dyspnoea	0	2
Headache	1	1

alone, one received benzodiazepines and hydroxyzine and one received benzodiazepines and chlorprothixene. Of the seven patients with psychosis, five (71 %) had no sedation or other pharmacotherapy and two (29 %) were given olanzapine.

The majority of patients (27; 77.1 %) were medically discharged from ED and three (8.6 %) self-discharged. Five (14.2 %) patients were admitted to hospital, of whom four were admitted to a psychiatric ward. The median length of stay in hospital was 2 h and 48 min (1 h and 43 min–6 h and 24 min).

Fatal Lone-Cannabis Case

There was one fatality amongst the 36 lone-cannabis cases. This was an 18-year-old male with a history of regular tobacco, alcohol and cannabis use. He had a history of migraine since childhood and a 1-year history of primary epilepsy; he had refused treatment with anti-convulsants but had been seizure free for a number of months. He collapsed whilst smoking cannabis with friends in a bar/nightclub; there was no seizure-like activity noted at the time of the collapse. He was found in asystole by the emergency medical service; he had 10 min of advanced cardiac life support which included intubation and a total dose of 3 mg of intravenous epinephrine. On arrival in the ED, shortly after the last dose of epinephrine, he had a heart rate of 120 bpm, blood pressure 225/130 mmHg, respiratory rate 16 per minute and GCS 3/15; blood glucose 13.5 mmol/L, lactate 5.9 mmol/L and pH 7.01. An echocardiogram and 12-lead ECG were normal; a computed tomography brain scan showed anoxic brain injury. The patient was transferred to coronary intensive care where he was treated supportively with therapeutic hypothermia. As sedation was reduced, there was no response from the patient and EEG and transcranial Doppler imaging confirmed anoxic brain injury. Life support was removed and the patient died 70 h post admission from irreversible anoxic brain damage. THC was detected on immunoassay (level of detection 50 ng/mL) in a urine sample taken at the time of arrival in the ED; benzodiazepines, amphetamine, cocaine and opiates were negative. No ethanol was detected in a blood sample taken on ED arrival. No post-mortem (autopsy) was performed. The clinicians managing the patient concluded that the sudden death was due to an unknown rhythm disturbance in the pre-hospital environment and subsequent hypoxic brain injury-related to the prolonged cardiac arrest.

Discussion

The results from 6 months of data collection in EDs around Europe show that there is considerable variation in the proportion of ED presentations with acute recreational drug toxicity that involve cannabis, from 10 % (one centre in Norway) to 48 % (one centre in Ireland), although these proportions cannot be considered to be representative of national statistics in these countries. Presentation with acute toxicity related to lone-cannabis use was uncommon—1.6 % of all presentations and 10.1 % of those involving cannabis. Polydrug use was the norm, with alcohol and benzodiazepines as the most common substances reported to be used together with cannabis. Presentations were most common amongst younger adult males, consistent with data on prevalence of cannabis use and treatment for problematic cannabis use in Europe [1]. This case series confirms that most patients with acute lone-cannabis toxicity develop self-limiting mild neuropsychiatric symptoms and/or vomiting that generally requires no treatment and results in only a short length of stay in the ED. However, there was one fatality in this case series in which the individual had a pre-hospital cardiac arrest whilst smoking cannabis. A post-mortem examination was not performed to exclude other causes of sudden cardiac death and so it is not possible to confirm that cannabis was the cause of death in this case.

There have been previous reports of sudden cardiac death temporally related to cannabis use [10–12]. The most recent of these was from Germany and describes post-mortem findings in two sudden deaths in individuals who were using cannabis [12]. The first was a 23-year-old male who collapsed with ventricular fibrillation whilst using public transport and died after 40 min of unsuccessful cardiopulmonary resuscitation. A post-mortem revealed atherosclerotic coronary artery disease and cardiac hypertrophy. THC and metabolites were detected in post-mortem samples; screening for other recreational drugs was negative. In the second case, a 28-year-old man was found dead at home. Post-mortem showed no gross abnormalities but histopathology of the heart showed several foci of single-cell necrosis; THC and metabolites were detected in post-mortem samples and other than nicotine/caffeine, no other drugs were detected. The authors postulated that both of these deaths were due to an acute cardiac event temporally related to cannabis use.

Another series from Norway described six cardiovascular fatalities in which THC (and no other illicit drugs) was measured in post-mortem blood [10]. Five were males aged 37–42 years with widespread atheromatous coronary artery disease at post-mortem. The sixth was a 17-year-old male with a history of illicit drug use whose post-mortem was reported to show "a slightly enlarged heart" but whose coronary arteries were normal.

There have been reports of acute coronary syndrome in cannabis users, temporally related to cannabis use and with analytical confirmation of THC [11, 13]. In a case crossover study, 3882 patients were interviewed a median of 4 days after having a myocardial infarction (MI) and 124 (3.2 %) reported using cannabis in the year preceding their MI [14]. Of these, 37 reported using cannabis within 24 h of the onset of their symptoms, nine within an hour and three between 60–90 min of the onset of their symptoms. Subsequent analysis which controlled for factors such as obesity, cigarette smoking and hypertension showed that the risk of MI within 1 h of smoking cannabis was moderately increased (relative risk 4.8 (95 % confidence interval (CI) 2.9–9.5; $p<0.001$) compared with periods of no use. In the second hour after using cannabis, the risk of MI was no longer significantly increased (relative risk 1.7, 95 % confidence interval 0.6–5.1; $p<0.34$).

In another report, a 34-year-old man who was a daily user of cannabis presented to the ED with a history of palpitations, presyncope and chest pain [15]. He had ventricular tachycardia (VT) which was successfully managed with cardioversion to normal sinus rhythm. Coronary angiography revealed normal coronary arteries, but there was a reduction in coronary blood flow related to microcirculatory impairment that improved with a 200 μg intracoronary injection of verapamil. VT was induced in the electrophysiology laboratory, and the patient was started on verapamil. A repeat coronary angiogram was normal including normal microcirculation and VT was not inducible on repeat electrophysiology testing.

There are also reports of arrhythmias temporally associated with cannabis use in the absence of coronary ischaemia, including two reports suggesting that there may be an association between cannabis use and the Brugada syndrome. A 42-year-old man who was a regular cannabis user presented to the ED with palpitations and a 12-lead ECG showed a type-I Brugada ECG pattern [16]. Electrophysiology testing with flecainide precipitated the Brugada pattern. After cannabis cessation, the type-I Brugada pattern was no longer seen on the patient's 12-lead ECG. In another report, a 19-year-old male presented after an episode of syncope associated with cannabis use; this was confirmed by toxicology screening of blood and urine samples which showed "markedly elevated levels of THC" and no other drugs [17]. A 12-lead ECG on presentation showed a Brugada pattern which normalised shortly after admission. There was no family history of sudden death. The patient was a non-smoker and had not used recreational drugs previously. An echocardiogram was normal, and the Brugada pattern was not induced by procainamide during electrophysiology testing.

There are several reports of atrial fibrillation following cannabis use. A 14-year old boy, with no previous or family history of heart disease developed palpitations and dizziness within an hour of smoking cannabis [18]. On arrival in the ED, his heart rate was irregular (55–88 bpm) but other observations and a neurological examination were normal. Serum and urine samples were positive for cannabis. His 12-lead ECG showed atrial fibrillation and an echocardiogram was normal. The patient was treated with oral digoxin and converted to normal sinus rhythm 12 h after the cannabis use. At 1-year follow-up (during which he had not used cannabis and was off digoxin), he remained in sinus rhythm. There are two further reports of self-limiting atrial fibrillation temporally related to cannabis use [19].

An epidemiological study using data from the National Institute of Mental Health Epidemiologic Catchment Area (EDA) Program investigated the potential association between cannabis use and palpitations [20]. This study matched to control for potential confounders and found that the use of cannabis was associated with a history of palpitations (relative risk 1.48 (95 % CI 1.21–1.81; $p<0.001$) with any use of cannabis and 1.91 (95 % CI 1.31–2.79, $p<0.001$) with daily use of cannabis). This was less marked than the association between cocaine use and a history of palpitations (relative risk 3.41, 95 % CI 1.60–7.29, $p<0.001$ for cocaine).

Taken as a whole, these reports suggest that there is a potential association between cannabis use and cardiotoxicity. Based on the available literature it is not possible to determine how common this is either amongst cannabis users or in terms of presentations the ED. Currently available data on acute toxicity related to recreational drugs in Europe is limited [21, 22], and it is not possible to collect reliable data on acute recreational drug presentations to the ED using current hospital coding systems [23, 24]. Euro-DEN will help to address this gap, and although it is only collecting data from sentinel EDs in ten European countries, the size of the dataset will enable us to produce information on the drugs responsible for ED presentations with acute recreational drug toxicity in Europe and the pattern of toxicity seen in these presentations [9]. For example, in our series of 2198 presentations to the ED with acute recreational drug toxicity reported through the Euro-DEN project, we identified one case of severe cardiotoxicity potentially associated with the use of cannabis.

Although most patients using only cannabis required no treatment in hospital, 60 % were taken to ED by ambulance. This indicates that the effects experienced were considered serious enough by the users (or those with them) to believe that medical attention was warranted. However, these individuals generally had mild clinical features and a short length of hospital stay. The attendance at, and transport to, hospital of patients who are not generally considered to be seriously ill

represents a cost burden to acute healthcare services and as means of reducing this, the cost of intervention programmes aimed at young male cannabis users may compare favourably.

There are some limitations to our dataset. We are collecting data from only a relatively small number of Emergency Departments and the drugs involved in the presentations are mostly based on patient self-report [9]. Therefore, the real burden of cannabis on emergency services might be underestimated. However, this represents current clinical practice in Europe where the management of patients with acute recreational drug toxicity is based on clinical assessment of the patient and self-reports of the drug(s) used and likely to be responsible for toxicity. Toxicological screening was carried out and cannabis use was confirmed in over a quarter of the patients in this case series. The pattern of cannabis use, such as the frequency and whether it was recreational or problematic, and the quantity used were not recorded. In addition, there is the potential for missing data variables in cases reported through the Euro-DEN project, since data is extracted from the ED and/or medical notes, rather than using a purpose-designed proforma [9]. However, this case series describes a group of patients which is not commonly reported on and illustrates how the Euro-DEN project will contribute towards the knowledge of acute recreational drug toxicity presentations to EDs across Europe.

Conclusions

In this series, acute cannabis toxicity was uncommon and involved in only a minority of acute recreational drug toxicity presentations. Lone acute cannabis toxicity presentations were typically associated with self-limiting neuro-behavioural features and vomiting and most were discharged from the ED. There was one death in this series, likely related to acute cannabis cardiovascular toxicity. Although uncommon following cannabis use, severe cardiovascular toxicity and death may be under-recognised, and it is important that Emergency Physicians are aware of this.

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