The title

Title: The clinical challenges of synthetic cathinones

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Running head: Cathinones; quantification and concerns

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Abstract

Within the new psychoactive substances (NPS) scenario, several hundreds of different molecules, mostly including synthetic cannabinoids and cathinones, have so far been identified. The aims of the paper were to: (a) identify the number of synthetic cathinones mentioned in a range of psychonaut, NPS-related, online sources; and (b) describe the associated acute/long term clinical scenario and the related treatment/management plan.

After about 18 months of operation and exclusion of false positives/duplicates, some 4204 unique NPS molecules were included in the 'NPS.Finder® crawling/navigating software database. Most popular NPS included: 1265 psychedelic phenethylamines (30.1%; CI 95%: 28.7-31.5%); 1253 synthetic cannabinoids (29.8%; CI 95%: 28.4-31.2%); 429 synthetic opioids (10.2%; CI 95%: 9.3-10.2%); and 171 synthetic cathinones (4.1%; CI 95% 3.5-4.7%). Conversely, the UNODC and the EMCDDA databases respectively included 169 and 140 cathinones. Overall, the three databases reported some 222 synthetic cathinones, and 41 were uniquely identified by the NPS.Finder®.

In terms of clinical scenarios, synthetic cathinone ingestion is initially associated with stimulant effects; psychopathological disturbances, violence, suicidal behaviour, hyperthermia, coma, and death have, however, been described as well.

The proportion of cathinones commented on by psychonaut fora appeared to be relatively small, and similar to those reported by both the UNODC and EMCDDA. This may be associated with a recent significant decline in both cathinone-related consumption and acute medical presentation. Due to their complex behavioural and medical toxicity issues, healthcare professionals should be however be educated to recognise the signs and symptoms of NPS, including synthetic cathinone, ingestion.

What is already known about this subject:

- Four categories of synthetic cathinones are typically described, e.g. those possessing: cocaine/MDMA-related effects (e.g. mephedrone); MDMA-like effects (e.g. methedrone); methamphetamine-like effects (e.g. cathinone); and pyrovalerone-like effects (e.g. MDPV);
- By April 2019, the European EMCDDA database had 749 NPS entries, whilst the latest United Nations' World Drug Report (UNODC) listed a total of 964 substances on their NPS database, with most molecules identified being synthetic cannabinoids and synthetic cathinones;
- It could be argued that the NPS total may be higher in number than those described by both the UNODC and the EMCDDA, with e-psychonaut-NPS discussions typically predicting the real life NPS scenario.

What this study adds:

- With the help of an *ad hoc* crawling/navigating software (NPS.Finder®), designed to automatically scan the open/surface web, some 4204 unique NPS molecules were identified, with 171 (4.1%; CI 95% 3.5-4.7%) being synthetic cathinones;
- NPS.Finder® has identified some 41cathinone molecules not known to either the UNODC or EMCDDA.
- Clinical ill-health consequences of taking cathinones may be wholly consistent with their neuropsychopharmacological characteristics. Initial stimulant effects are associated with a range of acute psychiatric disturbances, including violence/aggression and suicidal thoughts, together with hyperthermia, coma, and death;
- NPS, including synthetic cathinones, represent a challenge to healthcare, with complications of their use and their impact on services still being relatively unknown.

Introduction

Among new psychoactive substances (NPS), cathinones constitute a very relevant group to clinicians, policy-makers and other stake-holders (Guirguis et al, 2017). Mephedrone was reportedly first synthesized in 1929 (Saem de Burnaga Sanchez, 1929). In 2007, reports of 4-methylmethcathinone (mephedrone) use emerged, first in Israel and then in other countries and regions, including Australia, Scandinavia, Ireland and the United Kingdom (Kelly, 2011). In 2008, it was first reported to the European Early Warning System by the United Kingdom and by Finland, after being associated with adverse health effects (EMCDDA and Europol, 2011). Cathinones are beta-keto derivatives of phenylethylamines/amphetamines which are actively being subjected to minor modifications at the alkyl chains or the aromatic ring to create new synthetic molecules with the goal of circumventing laws (Majchrzak et al, 2018). Synthetic cathinones are usually insufflated or swallowed in their powder or crystal forms but can also be administered by injection, smoking, mucosal delivery, or injection via intramuscular or other routes (Schifano et al, 2015).

Clinical neuropharmacological issues

Cathinones are typically categorised based on either their pharmacological action or properties (Feng et al, 2017; Majchrzak et al, 2018), or in comparison to 'traditional' stimulant drugs (for a review of the issue, see Corkery et al, 2018). Some classifications consider their effects in relation to different substrates or non-substrate transporter inhibitors (Simmler et al, 2013). Four categories of synthetic cathinones are typically described in terms of their behavioural effects (for a thorough review, see Liechti, 2015; and Guirguis et al, 2017):

- Cocaine/3,4-Methylenedioxymethamphetamine (MDMA)-related effects; these are reported with a range of molecules including: mephedrone, 4-methylethcathinone (4-MEC), methylone, ethylone, butylone and naphyrone are substrates for the dopamine transporter (DAT), norepinephrine transporter (NET), and serotonin transporter (SERT) (Liechti, 2015);
- MDMA-related effects; associated with: methedrone and 4-trifluoromethylmethcathinone exhibit a higher inhibitory potency at SERT compared to their DAT activity, but at the same time promote release of both NE and 5-HT, like amphetamine analogues such as MDMA, paramethoxymethamphetamine (PMMA), paramethoxyamphetamine (PMA), and 4-ethylthioamphetamine (4-MTA) (Carlsson et al, 2018a; Simmler et al, 2014);
- Methamphetamine-like effects; associated with: cathinone, methcathinone, flephedrone, ethcathinone and 3-fluoromethcathinone are monoamine transporter substrates with DAT selective profiles; they show high inhibitory potencies at DAT and exhibit lower inhibitory potencies at

SERT (Simmler et al, 2013, 2014). They promote the release of NE and DA in a similar way to methylamphetamine (Liechti, 2015);

- Pyrovalerone-like effects; associated with: pyrovalerone, MDPV and alpha-pyrrolidinovalerophenone (α-PVP). They are non-substrate transporter inhibitors, showing inhibitory potencies at NET and DAT≥ methylamphetamine (Aarde et al, 2013) or cocaine (Baumann et al, 2013; Baumann et al, 2017). MDPV and α-PVP are both considered to be cocaine-like, whilst however being more effective reinforcers (Smith et al, 2017). Recent research on the pyrovalerone analogue alpha-pyrrolidinopentiothiophenone (α-PVT) suggests it has reinforcing and rewarding effects similar to those of both methylamphetamine and cocaine (Cheong et al, 2017).

It has been suggested that the reinforcing properties of cathinone stimulants are positively correlated with their selectivity for the dopamine (DAT) relative to the serotonin transporter (SERT; Baumann et al, 2017; Gannon et al, 2018; Dolan et al, 2018; Glennon and Young, 2016). Overall, synthetic cathinone pharmacokinetics can be somewhat predicted considering the modifications made to the core scaffold (Calinski et al, 2019). When ingested, the metabolic disposition of mephedrone (MEPH) in preclinical models is characterized by low bioavailability and an extensive hepatic metabolism (Martinez-Clemente et al, 2013). Its metabolism has been well described in rats (Meyer et al, 2010). In humans, Olesti et al (2019) carried out a randomized, crossover, phase I clinical trial. Subjects received 50 and 100 mg (n = 3) and 150 and 200 mg (n = 6) of mephedrone. Mephedrone peak concentrations were reached in 1 hour, with peak plasma concentrations and the amount of drug recovered in urine increasing with the doses administered, suggesting that mephedrone presented with a linear dose-dependence. MEPH presented a similar elimination constant rate (K e) (at ~0.3/hour) and elimination half-life (t 1/2) (of ~2 hours), irrespective of the administered dose. Mephedrone and methylone are chemically alike; conversely, MDPV presents with lower Tmax and t1/2 levels and pentylone shows longer t1/2 (for a thorough review of the issue, see Calinski et al, 2019). Several phase I metabolites retain pharmacodynamic activity; CYP2D6 is implicated in the metabolism of all synthetic cathinones, and this implies that recreational users with no or low CYP2D6 functionality are exposed to unwanted acute toxicity episodes (Olesti et al, 2019).

Up to 30% of mephedrone users may report dependence (Winstock et al, 2011), with synthetic cathinone users possibly experiencing as well both tolerance and withdrawal symptoms (Zawilska et al, 2013), which include tiredness, insomnia, nasal congestion, and impaired concentration (Schifano et al, 2011). Cathinone addicts commonly report re-injecting of the drug with excessive binge use over long periods of time, with shorter half-life and duration of effects leading to more compulsive drug-taking behaviour to maintain euphoria (Papaseit et al, 2017).

Number and types of NPS and synthetic cathinones in both real and online scenarios

By April 2019, the EMCDDA European Database on New Drugs (EDND) database had 749 entries, whilst the latest UN World Drug Report listed a total of 964 substances on their NPS database (UNODC, 2018a; EMCDDA, 2018a; EMCDDA, 2019; United Nations, 2019). Most molecules identified include synthetic cannabinoids and synthetic cathinones. However, it could be argued that the NPS scenario is much larger than that outlined by those molecules which have been seized and formally identified by both the UNODC and the EMCDDA. Since the *online* NPS scenario typically predicts the *real life* NPS scenario (Schifano et al, 2015; Corazza et al, 2013), identifying what is being discussed online by web-based NPS enthusiasts, or 'e-psychonauts' (Orsolini et al, 2015; Corkery et al, 2017), may well be of interest.

Aims

The aim of the paper was to: (a) identify and describe the number of synthetic cathinones available as identified from a range of psychonaut, NPS-related, online sources; and (b) describe both the acute/long term clinical scenarios associated with synthetic cathinone intake and the possible treatment/management plan to best cope with the medical and psychopathological associated ill-health consequences.

Materials and Methods

a) To facilitate the process of early recognition of the increasing dissemination of new substances online and the variability of information sources, a crawling/navigating software (i.e. the 'NPS.Finder®') was designed to automatically scan the *open/surface web* for new/novel/emerging NPS (Schifano et al, 2019). This was designed to map on a 24/7 basis the large variety of psychoactive molecules mentioned/discussed within a range of major and representative online psychonaut websites/forums. I

The NPS.Finder® was designed by Damicom, an IT enterprise based in Rome (Italy), to extract a range of information regarding NPS, including: chemical and street names; chemical formula; three-dimensional image; and anecdotally reported clinical/psychoactive effects. Resulting data were checked against the EMCDDA and UNODC NPS databases. The collection of further information was completed by consulting a range of open libraries and chemistry databases referring to the index item, if existing. These data were then automatically stored in an online, restricted access/password-controlled database located within firewall protected, highly secure, and consistently performing servers. A number of proper piloting searches were first carried out; with the help of most common search engines, including Google®, the informatics' staff started navigating using a range of key words, including: NPS; novel psychoactive substances; new psychoactive substances; emerging

psychoactive substances; drugs online; buy new substances; psychonauts, drug forums; psychoactive products; synthetic cannabinoids; synthetic cathinones; psychedelic phenethylamines; novel stimulants; synthetic opioids; tryptamine derivatives; phencyclidine-like dissociatives; piperazines; GABA-A/GABA-B receptor agonists; prescribed medications; psychoactive plants; psychoactive herbs; and image- and performance-enhancing drugs. Any new website of interest was added to the list, whose final version is attached as Appendix 1. Although the language most typically used in these websites was English, further languages here analysed by NPS.Finder® included: Dutch, French, Turkish, Swedish, Spanish, German, Russian, and Italian.
Afterwards, a range of specific web scraper/crawler activities, to extract all accessible posts/entries from 26th November 2017 to 31st May 2019, were carried out. Data were captured with the help of a range of Python language web crawlers, one for each font, through daily scanning activities. Emerging data were then imported and stored in a MYSQL database which presented with an SSL security protocol. All data were encrypted with asymmetric cryptographic procedures. Data were first stored in an intermediate virtual storage area. Eventually, with the help an 'ad hoc' check control panel, all data were manually and carefully analysed by 4 medically/psychiatrically-trained professionals (e.g. FN; DA; CZ; and LG). In case of data interpretation issues, these were resolved with the help of FS and AV. In this way, a full assessment and editing of each NPS.Finder® data entry was carried out and the range of unique synthetic cathinone molecules here commented were identified. When any new item was detected during the automated web scan, the system sent an e-mail notification/alert to the core researchers' mailing list. Eventually, these data were screened for both relevance and to exclude possible duplications. Finally, using chemical structure identification and published related data, researchers assigned each molecule to its NPS drug class, consistent with Schifano et al (2015).

b) To describe the medical and psychopathological issues most typically associated with the range of synthetic cathinone intake, the Medline/PubMed database(s) were searched for papers using the following keywords alone or in combination: 'new psychoactive substances', 'novel psychoactive substances', 'synthetic cathinones', 'medical consequences', 'psychopathological consequences', 'psychiatric consequences', and 'treatment and management of acute toxicity', 'clinical consequences', 'mephedrone', '4-methylethcathinone (4-MEC)', 'methylone', 'ethylone', 'butylone', 'naphyrone', 'methedrone', '4-trifluoromethylmethcathinone', 'methcathinone', 'flephedrone', 'ethcathinone', '3-fluoromethcathinone', 'pyrovalerone', 'MDPV', 'alpha-pyrrolidinovalerophenone (α-PVP)', and 'pyrrolidinopentiothiophenone (α-PVT)'.
In assessing the abstracts that were identified by the search, the papers of interest were narrowed down to focus on human reports only; the

description of both acute/chronic toxicity and dependence potential were included as well.

Nomenclature of Targets and Ligands
Key protein targets and ligands in this article are hyperlinked to corresponding entries in http://www.guidetopharmacology.org, the common portal for data from the IUPHAR/BPS Guide to PHARMACOLOGY.

Results

a) Data from the NPS.Finder® *web crawling activities*
After about 18 months of operation, the number of substances identified by the web crawler activities was 5922. By the time of writing, some 4204 unique NPS molecules were included in the database and 1718/5922 (29.01%) remaining molecules were designated as false positives/duplicates. Most popular NPS mentioned in the psychonaut forums included: 1265 psychedelic phenethylamines (30.1%; CI 95%: 28.7-31.5%); 1253 synthetic cannabinoids (29.8%; CI 95%: 28.4-31.2%); 429 synthetic opioids (10.2%; CI 95%: 9.3-11.1%); and 171 synthetic cathinones (4.1%; CI 95% 3.5-4.7%; see list in Appendix 2). Conversely, by the end of May 2019 the UNODC listed some 169 synthetic cathinones and, by 1st April 2019, the EMCDDA database included 140 different synthetic cathinones. Overall, the three databases identified some 222 synthetic cathinones. More precisely, some 121 cathinones were common to the 3 databases; 41 were uniquely identified by the NPS.Finder®; 37 were identified only by the UNODC and 7 only by the EMCDDA (for more details, see Appendix 2).

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b) Synthetic cathinone-related clinical issues; drafting a rational treatment and management plan
The search conducted for this study identified 40 papers focussing on either synthetic cathinone medical/psychopathological consequences and/or their treatment/management approach(es).
Clinical ill-health consequences following consumption of synthetic cathinones are overall consistent with their neuropsychopharmacological characteristics. After intake, initial stimulant effects e.g. euphoria, improved psychomotor speed, alertness, and talkativeness (Cheng et al, 2012) are typically observed. Acute psychiatric effects may, however, include as well: low mood, loss of appetite, difficulty sleeping, a degree of paranoid ideation, cognitive impairment, changes in perception, agitation, hallucinations, delusions, amnesia, confusion, violence, suicidal thoughts (Homman et al 2018; Kaizer-Będkowska et al, 2018) and excited delirium (Penders et al, 2012). With synthetic cathinones, suicides by hanging and deaths from firearm injuries have frequently been reported (Schifano et al, 2012; Marinetti and Antonides, 2013; Barrios et al, 2016).
Like amphetamine, synthetic cathinones result in medical side-effects consistent with sympathomimetic toxicity (Abbott et al, 2015; Roberts et

al, 2017; Batisse et al, 2016). Hence, acute intoxication issues include hypertension, tachycardia, cardiac, kidney and liver failure, rhabdomyolysis, electrolyte imbalance, metabolic toxicity, paradoxical hypoglycaemia (Ramirez Berlioz et al, 2019), and cerebral oedema (Adebamiro and Perazella, 2013; Borek and Holstege, 2012; Imam et al, 2013). Flushing, sweating, chills, restlessness, shortness of breath, dry mouth, abdominal pain, anorexia, vomiting, erectile dysfunction, and discolouration of the skin have been reported as well (Schifano et al, 2015). Le Roux et al (2015) analyzed some105 amphetamine-like (including synthetic cathinones; 10% of the total) drug poisoning cases. The most frequently reported symptoms included anxiety and hallucinations (49%), mydriasis and headache (41%), tachycardia (40%) and hypertension (15%). Complications such as seizures (7%), cardiac arrest (5%), toxic myocarditis (1%) and haemorrhagic stroke (1%) were also observed. Cathinone-induced acute intoxication may be characterized as well by symptoms/signs of the serotonin syndrome, which is associated with hyperthermia, psychotic disorders, catatonia and hyperactive delirium (Weaver et al, 2015; Denysenko et al, 2015).

Synthetic cathinone fatalities (Karila et al, 2011; Corkery et al, 2018) are typically attributed to hyperthermia (Kesha et al, 2013; Murray et al, 2012), hypertension, cardiac arrest and more in general to the classic serotonin syndrome (Warrick et al, 2012; Zaami et al, 2018). Only rarely was the concentration of the parent drug causing fatality higher than 1 mg/L in post-mortem biological fluids (Zaami et al, 2018). Ezaki et al (2016) compared data relating to victims from either 12 synthetic cathinone or cannabinoid intake and 10 methamphetamine cases. Whilst acute intoxication and cardiac ischaemia were the two most prominent causes of death in both synthetic cathinone/cannabinoid users and methamphetamine users, excited delirium syndrome, pulmonary aspiration and drowning were found only in synthetic cathinone/cannabinoid cases. Synthetic cathinone use alone is rare and the use of multiple substances may facilitate the occurrence of adverse effects, especially in females (for a review of the issue, see Lopez-Rodriguez et al, 2019). Of particular concern may be the significant enhanced effect on central DA levels of MDPV, mephedrone, and methylone taken in combination (Allen et al, 2019).

Once the initial phase of ingestion is over and the patient is medically stabilized, there may be a potential risk for long-term psychiatric problems (Salani et al, 2018; McCann et al, 1998). Furthermore, synthetic cathinones appear to induce neurocognitive dysfunction and cytotoxicity, which are dependent on drug type, dose, frequency, and time following exposure (Leyrer-Jackson et al, 2019). Also, orodental adverse effects, consistent with those observed with amphetamine, have been associated with a chronic exposure to synthetic cathinones (Abebe 2018). Finally, the intravenous administration of synthetic cathinones, which is not limited to the context of either the ‘chemsex’ (Giorgetti et al,

2017) or the 'slamming' (Batisse et al, 2016) scenarios, has been related to a range of behavioural problems (Schmoll et al, 2018).

Cathinone categories; clinical peculiarities

Taking into account cathinone's pharmacological (Simmler et al, 2013) and behavioural effects' classification described above (Guirguis et al, 2017), a few differences seem to emerge between the different categories.

Considering the *cocaine/MDMA-mixed effects' molecules* such as mephedrone and related compounds, mephedrone has been the most investigated (De Sousa Fernandes Perna et al, 2016; Karila et al, 2016). Furthermore, Roberts et al (2017) found that mexedrone, a mephedrone derivative, was found in 11 of 305 patients who presented to an emergency department (ED). All of them presented with agitation and 6 patients required sedation and/or physical restraint. Conversely, Karila et al (2016) emphasized that the potential chronic health effects (e.g., reproduction toxicity, genotoxicity and carcinogenic potential) of mephedrone/methylone prolonged use remain to date unknown.

No specific clinical concerns have been described for *MDMA-like effects' molecules* such as methedrone and 4-trifluoromethylmethcathinone. Conversely, in association with the misuse of *methamphetamine-like cathinones*, both Iqbal et al (2012), and Fudalej et al (2013) have highlighted the risk of manganese poisoning with Parkinsonism features reported in European clients who had injected self-prepared methcathinone hydrochloride (ephedrone) synthesized from pseudoephedrine hydrochloride using potassium permanganate as a potent oxidant.

Finally, increasing levels of clinical concerns have been associated with the use of *pyrovalerone-like molecules*, including alpha-PVP and MDPV, whose clinical effects are individual, dose- and route of administration-dependent (Karila et al, 2018). Palamar et al (2019) analysed data from a 2016/2017 large scale (n = 3786) US, high school senior subjects, study. Overall, 0.8% (95% CI: 0.5-1.2) of seniors was estimated to have used alpha-PVP ('Flakka'; 'zombie drug') over the previous year. Flakka users reported high prevalence of use of other drugs, particularly synthetic cannabinoids (85.6%), ketamine (72.3%), marijuana (59.1%), and GHB (47.5%). With alpha-PVP, a range of exaggerated symptoms, such as feelings of incredible strength, disorientation, aggression, and altered thought processes, together with high liability for abuse, tachycardia, agitation, hypertension, hallucinations, delirium, mydriasis, hyperthermia, and coma have been reported (Nóbrega and Dinis-Oliveira, 2018; Salani et al, 2018). Umebachi et al (2016) described a retrospective case series including eight subjects who had visited the local hospital ED between March 2012 and November 2014 and had analytically confirmed blood α-PVP levels. Drug preparations had been administered by rectal insertion or inhalation; the time interval between drug intake and ED presentation was 8.5 (1-24) h, with blood α-PVP concentrations ranging from 1.0 to

52.5 ng/ml. Symptoms of high body temperature (3/8), tachycardia (5/8), hypertension (3/8), acid-base balance disorder (5/8), coagulopathy (4/6), increased blood creatinine phosphokinase (6/8), and blood lactate levels (5/7) were observed. Use of 'flakka' has been associated with at least 80 deaths in the US (Palamar et al, 2019). In a forensic setting, MDPV was detected in blood and urine samples of 50 individuals involved in violent crimes, including bodily harm, robberies, homicides and acts of resistance. In many cases, subjects showed highly aggressive and violent behaviour; the risk for such behaviours increased with MDPV plasma concentrations above 30 mg/L (Diestelman et al, 2018). According to Szili and Bitter (2013), in Hungary there has been an increasing number of hospitalized patients with acute psychosis using MDPV. Finally, Dzhuvalyakov et al (2017) collected post mortem samples taken from 13 pyrrolidinovalerophenone poisoning victims from the Astrakhan region; they identified signs of chronic intoxication, which manifested themselves in the form of mixed gliosis and various lesions of brain neurons.

Cathinone intake; treatment/management plan

It is problematic to draft a universally valid treatment/management plan to cope with the medical, behavioural and psychopathological disturbances related to the intake of the virtually several hundred synthetic cathinones here identified, often taken in combination with the other traditional and new psychoactive substances (Schifano et al, 2018) currently available. Furthermore, it has been suggested that signs, symptoms, and treatment of toxicity with synthetic cathinones, synthetic cannabinoids, or dextromethorphan may overlap significantly (Brown et al, 2018; Shah and Baum, 2018). Consumers of synthetic cathinones may present to EDs without providing information about the substances(s) ingested; standard drug tests will show negative results; and sophisticated tests are not carried out as part of typical clinical practice (Schifano et al, 2016). Furthermore, neither GC-MS nor GC-FTIR alone can successfully differentiate between all synthetic cathinones (Carlsson et al, 2018b).

Some clients may simply need reassurance, support, and medical monitoring. Management of cathinone, and indeed of any NPS/unknown psychotropics' ingestion, is typically directed at dealing with adverse effects as they arise (Abdulrahim and Bowden-Jones, 2015). Due to the similarity of cathinones with other stimulants, management strategies similar to those recommended for intoxication with those drugs might be useful (Prosser and Nelson, 2012). For example, if a diagnosis of cathinone-induced delirium is suspected, treatment efforts should focus on controlling agitation and then treating medical complications such as metabolic acidosis (Abbott et al, 2015). Symptom-directed supportive care may also include the management of convulsions, hypertension/hypotension and rhabdomyolysis. Treatment of the cathinone-associated serotonin syndrome, which is often associated with agitation, may be managed using both benzodiazepines and

cyproheptadine (Schifano et al, 2016). The observation of asymptomatic patients should continue for a few hours (for a review, see also Abdulrahim and Bowden-Jones, 2015).
When medication is needed, given the cathinone complex/unknown pharmacology, benzodiazepines may be the agents of choice. Agitated adults be sedated with an initial dose of oral or intravenous diazepam (0.1–0.3 mg/kg body weight). At times, larger doses/frequent re-dosing to achieve adequate sedative effect may be required (Abdulrahim and Bowden-Jones, 2015; TOXBASE, 2019). Further targeted treatment to control aggression and agitation may include intramuscular or intranasal midazolam, or intramuscular lorazepam. This approach may be useful as well to stop seizures (Guirguis et al, 2017). Benzodiazepines, however, may be a problem whilst in presence of alcohol and, where patients cannot be controlled with benzodiazepines alone, propofol and/or antipsychotics may be considered. However, drugs such as haloperidol, olanzapine, or ziprasidone can lower seizure thresholds, and contribute to dysrhythmias (Schifano et al, 2016). In general, the use of atypical antipsychotics including the psychonauts' 'ideal trip terminator' (Valeriani et al, 2015) olanzapine, has shown good efficacy in containing episodes of aggression in different cohort and different phases of illness (Mauri et al, 2011). Finally, treatment for patients with prolonged exposure to synthetic cathinones should ideally include a drug management plan coupled with psychotherapy (Karila et al, 2016).

Discussion

The present paper provides unique, unprecedented, figures in terms of overall numbers of synthetic cathinones; it presents as well with an overview of the ill-health effects associated with the ingestion of these compounds, which are intended to mimic the effects of traditional stimulants.
The number of synthetic cathinones here identified with NPS.Finder® was comparable with that identified by the UNODC, and higher than that listed in the EMCDDA database. Out of the 222 synthetic cathinones overall identified by the 3 databases, NPS.Finder® captured 171/222 (77%) of them, a performance figure very similar to the UNODC one (169/222; 76%), but better than the EMCDDA one (140/222; 63%). One could argue that these differences may be due to the EMCDDA focusing on 28 EU countries only, whilst both the UNODC database and the psychonaut entries may better reflect the global situation.
Conversely, in comparison with remaining approaches, one would have hypothesized with the NPS.Finder® approach the mention by psychonauts of a much larger number of synthetic cathinones. In fact, if one considers the whole number of molecules identified through analysis of data based on psychonauts' discussions, the NPS.Finder® database has identified a quantitative level of NPS which is about 5-fold higher than those mentioned by both the UNODC and the EMCDDA (Schifano et al, 2019). It

is of interest to note, however, that synthetic cathinones accounted here for only 4.1% of the whole number of web crawler database molecules. This is in sharp contrast with UNODC data, where synthetic cathinones are second only to synthetic cannabinoids/'spice' in terms of number of NPS seized over the years (UNODC, 2018b). Similarly, synthetic cathinones were the NPS most seized in 2016 in the EU (EMCDDA 2018b). On the other hand, psychonauts may well focus their discussions, more than anything else, on those issues which are topical (Orsolini et al, 2015). Consistent with this, it is of interest to note that Webb et al (2019) found that cathinone-related presentations to UK EDs, over the last couple of years, significantly declined in number. Furthermore, the England and Wales 2017 survey data showed that last year mephedrone use among 16- to 34-year-olds was estimated at 0.2%, down from 1.1% in 2014/15 (EMCDDA, 2019). This is echoed by a fall in the number and quantity of mephedrone seized by UK law enforcement agencies (Home Office, 2018a; 2018b; Scottish Government, 2019; PSNI, 2019), as well as those presenting for treatment for mephedrone in England (PHE 2018a; 2018b), and those whose deaths involved mephedrone (Corkery et al, 2018). In other words, there might have been a recent decline in interest towards synthetic cathinones, and one could wonder if this is linked to increased availability of higher purity/high dose MDMA/psychedelic phenethylamine products (EMCDDA, 2019). One could also argue that the market has reached a point of saturation for molecules being offered to synthetic cathinone enthusiasts.

From the present overview, it seems that together with the vast range of NPS, synthetic cathinones represent a clinical challenge, with complications of their use and their impact on services still being relatively unknown (Henshall et al, 2018). Indeed, synthetic cathinone intake is typically associated with an imbalance of a range of neurotransmitter pathways/receptors, and consequently with a significant risk of both medical and psychopathological disturbances, at times accompanied by bizarre behaviour and significant violence/aggression levels (Schifano et al, 2015). Only a paucity of information exists on the biological, physiological, and toxicological effects of synthetic cathinones, especially regarding their long-term effects after heavy and prolonged use. It is paramount that healthcare professionals are able to recognize the signs and symptoms of synthetic cathinone ingestion, know the steps to take to ensure safety of the patient and those around him or her (Salani et al, 2018).

Vulnerable subjects, including both children/adolescents and psychiatric patients, may be exposed to large number of pro drug web pages, from which anecdotal levels of knowledge related to both well-known and novel psychotropics are typically provided by 'e-psychonauts' (e.g. drug forums/blog communities' members). Hence, future approaches should consider the role of web-based preventative strategies in targeting youngsters/vulnerable individuals at risk of approaching the drug market.

Limitations
It has to be emphasized here that the NPS.Finder® crawled so far on the open web only. Since there may well be further information available on both the deep web and the dark net, future studies of our group will be focussing on expanding drug searches on these less accessible areas of the web. NPS.Finder®-based studies will need to focus as well on further languages, which should include as well: Chinese; Japanese; and Arabic, since previous studies have highlighted their importance in NPS-based studies (Deluca et al, 2012). Furthermore, from a formal point of view the current literature review would not be considered as 'systematic'. Instead, it was conceived as a literature overview, focussing on the cathinone clinical issues of interest.

Conclusions
More studies should aim at providing better levels of misusing drugs' clinical pharmacological-related knowledge, so that properly tailored management/treatment strategies and guidelines can be drawn up and made available.
Because of the complex behavioural and medical toxicity issues, raising awareness of and education on drugs' health harms, interventions, harm reduction techniques, and referral pathways are here considered to be of relevance for health care professionals (Guirguis et al, 2017; Pourmand et al, 2018).

Conflict of interest
The authors have no conflicts of interest to declare.

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Website name (alphabetical order)
1. ***Avalonmagicplants.com***
2. ***Azarius.net***
3. ***Bluelight.org***
4. ***Bluemorphotours.com***
5. ***Cannabis.net***
6. ***Chemeurope.com***
7. ***Committedpsychonaut.tumblr.com***
8. ***Daath.hu/psychonauts***
9. ***Dancesafe.org***
10. ***Deviantart.com/psychonaut-a***
11. ***Druglibrary.org***
12. ***Drugs.tripsit.me***
13. ***Drugs-forum.com***
14. ***Drugs-plaza.com***
15. ***Dutch-headshop.eu***
16. ***Ecstasydata.org***
17. ***Elephantos.com***
18. ***Energycontrol.org***
19. ***Entheogen-network.com/forums***
20. ***Erowid.org***
21. ***Eusynth.org***
22. ***Everything2.com/title/Psychonaut***
23. ***Fungifun.org***
24. ***Hedweb.com***
25. ***Hipforums.com/forum***
26. ***Isomerdesign.com***
27. ***Knehnav.home.xs4all.nl***
28. ***Kratomshop.com***
29. ***Legal-high-inhaltsstoffe.de***
30. ***Mindstates.org***
31. ***Mycotopia.net***
32. ***Natmedtalk.com***
33. ***Peyote.com/peyolink.html***
34. ***Psychedelic-library.org***
35. ***Psychonaut.ca***
36. ***Psychonaut.fr***
37. ***Psychonautdocs.com***
38. ***Psychonautwiki.org***
39. ***Psyconauts.tripod.com***
40. ***Reddit.com and drug-related subreddits (e.g. Reddit.com/r/Psychonaut/; Reddit.com/r/shroomers/)***
41. ***Shayanashop.com***
42. ***Sjamaan.com***

43. Tripzine.com
44. Tryptamind.com
45. Urban75.net
46. Zamnesia.com

Appendix 1: List of websites monitored by the NPS.Finder® web crawler during the time frame November 2017-May 2019; surface web only

N	Synthetic cathinone molecule	Other names	IUPAC denomination	UNODC	EMCDDA	NPS Finder
1	1-(1,3-benzodioxol-5-yl)-2-(benzylamino)butan-1-one	BMDB; 2-Benzylamino-1-(3,4-methylenedioxyphenyl)butan-1-one; N-Benzylnorbutylone	1-(1,3-Benzodioxol-5-yl)-2-(benzylamino)butan-1-one	Y	Y	Y
2	1-(1,3-benzodioxol-5-yl)-2-(cyclopropylamino)propan-1-one	cPRONE; 1-(2H-1,3-Benzodioxol-5-yl)-2-(cyclopropylamino)propan-1-one	1-(1,3-Benzodioxol-5-yl)-2-(cyclopropylamino)propan-1-one	N	N	Y
3	1-(1,3-benzodioxol-5-yl)-2-(dimethylamino)pentan-1-one	Dipentylone; betaK-Dmbdp; Bk-dmbdp; DMBDP; 2-(dimethylamino)-3,4-(methylendioxy)-Valerophenone; 2-(dimethylamino)-3,4-(methylenedioxy)-1-Pentanone, 1-(1,3-benzodioxol-5-yl)-2-(dimethylamino)-; 803614-36-0; MDDMVP; 1-(1,3-Benzodioxol-5-yl)-2-(dimethylamino)pentan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-(dimethylamino)pentan-1-one	Y	Y	Y
4	1-(1,3-benzodioxol-5-yl)-2-(propylamino)butan-1-one	bk-PBDB	1-(1,3-benzodioxol-5-yl)-2-(propylamino)butan-1-one	Y	Y	Y
5	1-(2,3-dihydro-1H-inden-5-yl)-2-(ethylamino)pentan-1-one	bk-IVP	1-(2,3-dihydro-1H-inden-5-yl)-2-(ethylamino)pentan-1-one	Y	Y	Y
6	1-(2,3-dihydro-1H-inden-5-yl)-2-(methylamino)propan-1-one	bk-IMP; βk-IMP; 1-(2,3-dihydro-1H-inden-5-yl)-2-(methylamino)-1-propanone; beta-keto-indanylmethylaminopropane	1-(2,3-Dihydro-1H-inden-5-yl)-2-(methylamino)propan-1-one	Y	Y	Y
7	1-(2,3-dihydro-1H-inden-5-yl)-2-phenyl-2-(pyrrolidinyl-1-yl)ethan-1-one	Indapyrophenidone	1-(2,3-dihydro-1H-inden-5-yl)-2-phenyl-2-(pyrrolidin-1-yl)-ethanone	Y	Y	Y
8	1-(2,4-dimethylphenyl)-2-(ethylamino)propan-1-one	2,4-DMEC , 2,4-Dimethyletcathinone; 2,4-Dimethylethcathinone; 1-Propanone, 1-(2,4-dimethylphenyl)-2-(ethylamino)-	1-(2,4-dimethylphenyl)-2-(ethylamino)propan-1-one	Y	Y	Y
9	1-(2,4-dimethylphenyl)-2-(methylamino)propan-1-one	2,4-DMMC, 2,4-Dimethylmetcathinone	1-(2,4-dimethylphenyl)-2-(methylamino)propan-1-one	Y	Y	Y
10	1-(2,4-dimethylphenyl)-2-(pyrrolidin-1-yl)propan-1-one	2,4-DMPPP	1-(2,4-Dimethylphenyl)-112-(1-pyrrolidinyl)-1-propanone	Y	Y	Y
11	1-(2H-1,3-benzodioxol-5-yl)-2-[(propan-2-yl)amino]propan-1-one	iPrONE; 1-(2H-1,3-Benzodioxol-5-yl)-2-[(propan-2-yl)amino]propan-1-one; 1-(1,3-Benzodioxol-5-yl)-2-(propan-2-ylamino)propan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-[(propan-2-yl)amino]propan-1-one	N	N	Y
12	1-(3-fluorophenyl)-1-(methylamino)propan-2-one	3-Fluoroisomethcathinone, 3-FiMC; Scorpion	1-(3-fluorophenyl)-1-(methylamino)-2-propanone	Y	N	Y
13	1-(3-fluorophenyl)-2-(pyrrolidin-1-yl)pentan-1-one	3F-α-PVP, 3F-alpha-PVP	1-(3-fluorophenyl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	N
14	1-(3-Methylphenyl)-2-(pyrrolidin-1-yl)propan-1-one	3-MePPP	2-(pyrrolidin-1-yl)-1-(m-tolyl)propan-1-one	Y	N	N
15	1-(3,4-dimethoxyphenyl)-2-(ethylamino)pentan-1-one	DL-4662	1-(3,4-dimethoxyphenyl)-2-(ethylamino)pentan-1-one, monohydrochloride	Y	Y	Y
16	1-(3,4-Methylenedioxyphenyl)-2-methyl-2-pyrrolidinyl-1-propanone	MDMPPP	3-(1-(benzo[d][1,3]dioxol-5-yl)-2-methylpyrrolidin-2-yl)propanal	Y	N	N

17	1-(4-bromophenyl)-2-(pyrrolidin-1-yl)propan-1-one	4-Br-alpha-PPP; 4-bromo-alpha-pyrrolidinopropiophenone; 4-Br-α-PPP	1-(4-Bromophenyl)-2-(pyrrolidin-1-yl)propan-1-one	Y	Y	Y
18	1-(4-chlorophenyl)-2-(isopropylamino)propan-1-one	4-CIC; 4-chloroisopropylcathinone; 4-chloroiprcathinone; clipredrone	1-(4-Chlorophenyl)-2-(isopropylamino)propan-1-one	Y	Y	Y
19	1-(4-chlorophenyl)-2-(pyrrolidin-1-yl)propan-1-one	4′-chloro-α-PPP	1-(4-chlorophenyl)-2-(pyrrolidin-1-yl)propan-1-one	Y	Y	N
20	1-(4-Fluorophenyl)-2-(isopropylamino)pentan-1-one4-fluoro-N-isopropylnorpentedrone	4F-IPV; 4-F-IPV; 4-fluoro-N-isopropylnorpentedrone; 1-(4-fluorophenyl)-2-(isopropylamino)pentan-1-one; 4F-IPV; 4F-NPP; 4F-NIPP; 4-fluoro-N-isopropylnorpentedrone	1-(4-Fluorophenyl)-2-(1-methylethylamino)pentan-1-one	Y	Y	Y
21	1-(4-fluorophenyl)-2-(methylamino)pentan-1-one	4-Fluoropentedrone, 4-FPD	1-(4-fluorophenyl)-2-(methylamino)pentan-1-one	Y	Y	Y
22	1-(4-fluorophenyl)-2-(piperidin-1-yl)pentan-1-one	4-fpd; 4-Fluoropentedrone ; 4-f-pentedrone; 4f-pentedrone	1-(4-fluorophenyl)-2-(methylamino)pentan-1-one, monohydrochloride	Y	Y	Y
23	1-(4-fluorophenyl)-2-(pyrrolidin-1-yl)heptan-1-one	4F-PEP, 4F-PV8; 4-fluoro-α-PHPP; p-fluoro-α-PHPP; p-fluoro-PV8; para-fluoro-α-PHPP; para-fluoro-PV8; 4-F-α-PEP	1-(4-fluorophenyl)-2-(pyrrolidin-1-yl)heptan-1-one	Y	Y	Y
24	1-(4-fluorophenyl)-2-(pyrrolidin-1-yl)octan-1-one	4F-α-POP, 4F-PV9; 4-fluoro-alpha-pyrrolidinooctanophenon; 4F-PV9	1-(4-Fluorophenyl)-2-(pyrrolidin-1-yl)octan-1-one	Y	Y	Y
25	1-(4-Methoxyphenyl)-2-(pyrrolidin-1-yl)butan-1-one	4-MeO-α-PBP; 4-methoxy-alpha-pyrrolidinobutiophenone; 4-MOPBP	1-(4-methoxyphenyl)-2-pyrrolidinilbutan-1-one	Y	Y	Y
26	1-(4-methoxyphenyl)-2-(pyrrolidin-1-yl)octan-1-one	4-MeO-alpha-POP, 4-MeO-α-PV9; para-methoxy PV9; 4-methoxy-α-PV9	4-methoxy-alpha-pyrrolidinooctanophenone	Y	Y	Y
27	1-(4-Methylphenyl)-2-dimethylaminobutan-1-one	4-Methyl-N-methylbuphedrone; 2-(Dimethylamino)-1-(4-methylphenyl)butan-1-one	2-(dimethylamino)-1-(4-methylphenyl)butan-1-one	Y	N	N
28	1-(4-Methylphenyl)-2-ethylaminobutan-1-one	18268-19-4; 4-Me-NEB	2-(ethylamino)-1-(p-tolyl)butan-1-one	Y	N	N
29	1-(4-methylphenyl)-2-methylamino-pentan-1-one	4-MPD, 4-Methylpentedrone; 4-Methylpentedrone; 4-Methyl-α-methylamino-valerophenone	1-(4-Methylphenyl)-2-methylamino-pentan-1-one	Y	Y	Y
30	1-(naphthalen-1-yl)-2-(pyrrolidin-1-yl)pentan-1-one	1-naphyrone; Naphth-1-yl isomer of naphyrone	1-(naphthalen-1-yl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y
31	1-Phenyl-1,2-propanedione-2-oxime	1-phenyl-1,2-propanedione-2-oxime; 2-hydroxyimino propiophenone; isonitrosopropiophenone; 2-hydroxyiminopropiophenone; 2-hydroxyimino-1-phenylpropan-1-one; propiophenone isonitroso; 2-isonitrosopropiophenone; alpha-oximinopropiophenone; 1-phenyl-1,2-propanedione 2-oxime; .alpha.-oximinopropiophenone	(2E)-2-hydroxyimino-1-phenylpropan-1-one	Y	N	N
32	1-phenyl-2-(piperidin-1-yl)butan-1-one	α-Piperidinobutiophenone, alpha-PipBP; α-PipBP	2-Piperidino-1-phenylbutan-1-one	Y	Y	Y
33	1-phenyl-2-(pyrrolidin-1-yl)octan-1-one	α-POP, PV9; Alpha-pyrrolidinooctanophenone; PV-9; No Limit; 1-Phenyl-5-vinyl-2-imidazolidinethione; PV-Izt; 2-Imidazolidinethione, 5-ethenyl-1-phenyl-	5-ethenyl-1-phenylimidazolidine-2-thione	Y	Y	Y
34	2-(benzylamino)-1-(4-methylphenyl)butan-1-one	Bn-4MeMABP, 4-methylbuphedrone, N-benzyl derivative	2-(benzylamino)-1-(4-methylphenyl)butan-1-one	Y	Y	Y
35	2-(Ethylamino)-1-(4-methylphenyl)pentan-1-one	4-MEAP, 4-MEAPP, 4-Methyl-N-ethylnorpentedrone; 1-p-Tolyl-2-ethylamino-pentanone-(1); N-ethyl-4-methylnorpentedrone; 4-MEAPNEMNP	2-(ethylamino)-4-methyl-valerophenone	Y	Y	Y

36	2-(isopropylamino)-1-phenylpentan-1-one	NiPP; N-isopropylpentedrone; 2-IPP	1-phenyl-2-(1-methylethylamino)pentan-1-one	Y	Y	Y
37	2-(methylamino)-1-(naphthalen-1-yl)propan-1-one	AMAPN	2-(methylamino)-1-naphthalen-1-ylpropan-1-one	Y	Y	N
38	2-(methylamino)-1-(naphthalen-2-yl)propan-1-one	BMAPN	2-(methylamino)-1-naphthalen-2-ylpropan-1-one	Y	N	N
39	2-amino-1-(2,5-diethoxyphenyl)propanone	2,5-DEA-bk; 2,5-DEA-βk	2-Amino-1-(2,5-diethoxyphenyl)propan-1-one	N	N	Y
40	2-amino-1-(4-bromo-2,5-dimethoxyphenyl)ethan-1-one	bk-2C-B; βk-2C-B	2-Amino-1-(4-bromo-2,5-dimethoxyphenyl)ethan-1-one	Y	Y	Y
41	2-aminopropan-1-one	2-Aminopropanone	2-Aminopropan-1-one	N	N	Y
42	2-aminopropiophenone	1-aminoethyl, phenyl ketone	2-amino-1-phenylpropan-1-one;	N	N	Y
43	2-chloroethcathinone	2-CEC	1-(2-chlorophenyl)-2-(ethylamino)propan-1-one	Y	N	N
44	2-Ethyl-N-ethylcathinone	2-EEC	2-(ethylamino)-1-(2-ethylphenyl)propan-1-one	Y	N	N
45	2-Ethyl-N-methylcathinone	2-EMC	2-[ethyl(methyl)amino]-1-phenylpropan-1-one	Y	N	N
46	2-Fluoromethcathinone	2-FMC; ortho-fluoromethcathinone; 2-fluoro-N-methylcathinone	1-(2-fluorophenyl)-2-(methylamino)propan-1-one	Y	Y	Y
47	2-HO-5-EPEA-bk	2-Amino-1-(5-ethoxy-2-hydroxyphenyl)ethan-1-one; 2-HO-5-EPEA-βk	2-Amino-1-(5-ethoxy-2-hydroxyphenyl)ethan-1-one	N	N	Y
48	2-HO-N-Me-5-EA-bk	1-(5-Ethoxy-2-hydroxyphenyl)-2-(methylamino)propan-1-one	1-(5-Ethoxy-2-hydroxyphenyl)-2-(methylamino)propan-1-one	N	N	Y
49	2-HO-N-Me-5-EPEA-bk	1-(5-Ethoxy-2-hydroxyphenyl)-2-(methylamino)ethan-1-one	1-(5-Ethoxy-2-hydroxyphenyl)-2-(methylamino)propan-1-one	N	N	Y
50	2-methyl-1-(4-(methylthio)phenyl)-2-morpholinopropan-1-one	MMMP	2-methyl-1-(4-methylsulfanylphenyl)-2-morpholin-4-ylpropan-1-one	Y	N	N
51	2-Methyl-1-phenyl-2-(3-pyridinyl)-1-propanone	2-MPPP	n-piperidinecathinone	N	N	Y
52	2-Methyl-N-methylcathinone	2-methylethylcathinone; 2-methylethcathinone; 2-MEC	2-(ethylamino)-1-(o-tolyl)propan-1-one	Y	Y	Y
53	2-Methylethcathinone	2-MEC; 2-methylethylcathinone;	2-(ethylamino)-1-(o-tolyl)propan-1-one	Y	Y	Y
54	2-pyrrolidin-1-yl-1-tetralin-6-yl-hexan-1-one	TH-PHP	2-(pyrrolidin-1-yl)-1-(5,6,7,8-tetrahydronaphthalen-2-yl)hexan-1-one	Y	Y	Y
55	2-pyrrolidin-1-yl-1-tetralin-6-yl-pentan-1-one	TH-PVP	2-(pyrrolidin-1-yl)-1-(5,6,7,8-tetrahydronaphthalen-2-yl)pentan-1-one	Y	Y	Y
56	2,3-Methylenedioxymethcathinone	2,3-MDMC	1-(2H-1,3-benzodioxol-4-yl)-2-(methylamino)propan-1-one	Y	N	N
57	2,3-Pentylone		1-(1,3-benzodioxol-4-yl)-2-(methylamino)pentan-1-one	Y	N	N
58	2,4,5-Trimethylmethcathinone	2,4,5-TMMC	2-(Methylamino)-1-(2,4,5-trimethylphenyl)propan-1-one	Y	Y	Y

59	2,5-dimethoxycathinone	2,5-DMA-bk; 2,5-DMA-βk	2-Amino-1-(2,5-dimethoxyphenyl)propan-1-one	N	N	Y
60	3-Bromomethcathinone	3-BMC; 3-bromomethcathinone; 2-methylamino-1-(3-bromophenyl)propan-1-one; 1-propanone, 1-(3-bromophenyl)-2-(methylamino)-; 3-BMAP	1-(3-bromophenyl)-2-methylaminopropan-1-one	Y	Y	Y
61	3-chloroethcathinone	3-CEC	1-(3-chlorophenyl)-2-(ethylamino)propan-1-one	Y	Y	N
62	3-chloromethcathinone	3-CMC; 3-chloromethcathinone; Clophedrone	1-(3-chlorophenyl)-2-(methylamino)propan-1-one	Y	Y	Y
63	3-Ethyl-N-ethylcathinone	3-EEC	2-(ethylamino)-1-(2-ethylphenyl)propan-1-one	Y	N	N
64	3-ethylmethcathinone	3-EMC	1-(3-ethylphenyl)-2-(methylamino)propan-1-one	Y	N	N
65	3-Fluoroethcathinone	3-FEC	2-(ethylamino)-1-(3-fluorophenyl)propan-1-one, monohydrochloride	Y	N	N
66	3-Fluoromethcathinone	1346600-40-5 (HCl), 3-FMC ; 3-Flephedrone; 3-fluoro-N-methylcathinone	1-(3-fluorophenyl)-2-(methylamino)propan-1-one	Y	Y	Y
67	3-methoxy-alpha-pyrolidinopropiophenone	α-PPP-MeO, 3-MeO-α-PPP; 2-pyrrolidino-3-methoxy-propiophenone; PMeOPP	1-(3-methoxy-1-oxo-1-phenylpropan-2-yl)pyrrolidine	Y	Y	Y
68	3-Methoxymethcathinone	1435933-70-2, 3-MeOMC; 3-MOMC; 3-MMA-βk	1-(3-methoxyphenyl)-2-(methylamino)propan-1-one	Y	Y	Y
69	3-Methylethcathinone	3-MEC; 3-Methylethylcathinone	2-(ethylamino)-1-(m-tolyl)propan-1-one	Y	Y	Y
70	3-methylflephedrone	3-methyl-4-fluoromethcathinone	1-(4-Fluoro-3-methylphenyl)-2-(methylamino)propan-1-one	Y	Y	Y
71	3-methylmethcathinone	3-MMC; metaphedrone	(RS)-2-(methylamino)- 1- (3-methylphenyl)- 1-propanone	Y	Y	Y
72	3,4-dichloro-N, N-cyclohexylmethylmethcathinone	3,4-DCCHMMC	2-(cyclohexyl(methyl)amino)-1-(3,4-dichlorophenyl)propan-1-one	Y	Y	Y
73	3,4-dichloroethcathinone	3,4-dichloro-N-ethylcathinone; 3,4-DCEC	1-(3,4-dichlorophenyl)-2-(ethylamino)-1-propanone	Y	Y	Y
74	3,4-dimethoxy-α-pyrrolidinovalerophenone	850442-84-1; 3,4-DiMeO-alpha-PVP; 1-(3,4-Dimethoxyphenyl)-2-(1-pyrrolidinyl)-1-pentanone; 3,4-Dimethoxy-α-pyrrolidinovalerophenone; 3,4-DMeO-α-PVP	1-(3,4-dimethoxyphenyl)-2-(1-pyrrolidinyl)-1-pentanone	Y	Y	Y
75	3,4-dimethoxymethcathinone	3,4-DMeOMC	1-(3,4-dimethoxyphenyl)-2-(methylamino)-1-propanone, monohydrochloride	Y	N	N
76	3,4-dimethyl-alpha-PVP	3,4-dimethyl-α-PVP	1-(3,4-dimethylphenyl)-2-(pyrrolidin-1-yl)pentan-1-one, monohydrochloride	Y	N	N
77	3,4-dimethyl-N-ethylbuphedrone	3,4-dimethyl-NEB	1-(3,4-dimethylphenyl)-2-(ethylamino)butan-1-one	Y	N	N
78	3,4-Dimethylethcathinone	3,4-DMEC	1-(3,4-dimethylphenyl)-2-	Y	Y	Y

			(ethylamino)propan-1-one			
79	3,4-Dimethylmethcathinone	1081772-06-6 (HCl), 3,4-DMMC	(±)-1-(3,4-Dimethylphenyl)-2-(methylamino)propan-1-one	Y	Y	Y
80	3,4-DMeO-alpha-PHP	3,4-DMeO-α-PHP	1-(3,4-dimethoxyphenyl)-2-(pyrrolidin-1-yl)hexan-1-one	Y	Y	Y
81	3,4-Ethylenedioxymethcathinone	3,4-EDMC	1-(2,3-dihydro-1,4-benzodioxin-6-yl)-2-(methylamino)-1-propanone, monohydrochloride	Y	N	N
82	3,4-Methylenedioxy-alpha-pyrrolidinohexanophenone	MDPHP; MD-PHP; 3,4-Methylenedioxy-α-pyrrolidinohexiophenone; monkey dust	1-(benzo[d][1,3]dioxol-5-yl)-2-(pyrrolidin-1-yl)hexan-1-one	Y	Y	Y
83	3,4-Methylenedioxy-N-benzylcathinone	3,4-MDBC; BMDP; 2-Benzylamino-1-(3,4-methylenedioxyphenyl)propan-1-one	1-(1,3-benzodioxol-5-yl)-2-(benzylamino)propan-1-one	Y	Y	Y
84	3,4-methylenedioxy-N-tert-butylcathinone	tBuONE; MDPT; D-Tertylone	3,4-Methylenedioxy-N-tert-butylcathinone	Y	Y	Y
85	3,4-Methylenedioxy-N,N-dimethcathinone	109367-07-9, bk-MDDMA, bk-DMBDP, DYMETHILONE; DMONE; N,N-Dimethyl MDCATH; N,N-Dimethyl-3,4-methylenedioxycathinone; N,N-Dimethyl-β-keto-3,4-methylenedioxyamphetamine; 1-(1,3-Benzodioxol-5-yl)-2-(dimethylamino)-1-propanone; 1-Propanone, 1-(1,3-benzodioxol-5-yl)-2-(dimethylamino)-; Propiophenone, 2-dimethylamino-3,4-methylenedioxy-;	1-(2H-1,3-Benzodioxol-5-yl)-2-(dimethylamino)propan-1-one	Y	Y	Y
86	3,4-Methylenedioxy-α-pyrrolidinobutyrophenone or 3,4-Methylenedioxy-alpha-pyrrolidinobutyrophenone	24622-60-4; MDPBP; 3,4-Methylenedioxy-α-pyrrolidinobutyrophenone; NRG-1 (mixture)	1-(1,3-benzodioxol-5-yl)-2-pyrrolidin-1-ylbutan-1-one	Y	Y	Y
87	3,4-Methylenedioxy-α-pyrrolidinopropiophenone	24698-57-5; MDPPP; 3,4-Methylenedioxy-α-pyrrolidinopropiophenone; 1-(1,3-Benzodioxol-5-yl)-2-(pyrrolidin-1-yl)propan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-(pyrrolidin-1-yl)propan-1-one	Y	Y	Y
88	3,4-Methylenedioxycathinone	BK-MDA	2-amino-1-(1,3-benzodioxol-5-yl)propan-1-one	Y	N	N
89	3,4-Methylenedioxypyrovalerone	687603-66-3; MDPV; Methylendioxypyrovalerone; Bath Salts (generic); NRG-1 (mixture); 3,4-Methylenedioxypyrovalerone	1-(1,3-Benzodioxol-5-yl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y
90	3',4'- Methylenedioxy-alpha-methylPPP	MDMPP; 1-(3,4-Methylenedioxyphenyl)-2-methyl-2-pyrrolidinyl-1-propanone	3',4'- Methylenedioxy-alpha-methylPPP; Methylenedioxy-alpha-methylPPP	N	Y	Y
91	4-Bromo-alpha-pyrolidinovalerophenone	4Br-alpha-PVP	1-(4-Bromophenyl)-2-(1-pyrrolidinyl)-1-pentanone	Y	Y	Y
92	4-Bromoethcathinone	4-BEC	1-(4-bromophenyl)-2-(ethylamino)-1-propanone	Y	Y	Y
93	4-Bromomethcathinone	486459-03-4, 4-BMC, 4-BMAP; Brephedrone; 4-Bromo-alpha-(methylamino)propiophenone; 1-Propanone, 1-(4-bromophenyl)-2-(methylamino)-	1-(4-Bromophenyl)-2-(methylamino)propan-1-one	Y	Y	Y
94	4-chloro-alpha-pyrrolidinovalerophenone	4-Cl-alpha-PVP; 4-chloro-α-PVP; 4-chloro-α-Pyrrolidinopentiophenone; 4-	1-(4-chlorophenyl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y

		chloro-2-(1-pyrrolidinyl)-Valerophenone; 4-CL-PVP; 4-C-PVP				
95	4-chloro-N,N-dimethylcathinone	4-CDMC, 4-CDC	4-chloro-N,N-dimethylcathinone	Y	Y	Y
96	4-chlorobutylcathinone	4-chloro-N-butylcathinone, 4-CBC ; para-Butyl-N-Chlorocathinone	2-(butylamino)-1-(4-chlorophenyl)-1-propanone	Y	Y	Y
97	4-chloroethcathinone	4-CEC	1-(4-chlorophenyl)-2-(ethylamino)-1-propanone	Y	Y	Y
98	4-chloromethcathinone	4-CMC, CLEPHEDRONE	1-(4-chlorophenyl)-2-(methylamino)-1-propanone	Y	Y	Y
99	4-Chloropentedrone	4-chloro-alpha-methylamino-pentiophenone; 4-chloro-alpha-methylamino-valerophenone; 4-CPD	1-(4-chlorophenyl)-2-(methylamino)pentan-1-one	Y	Y	Y
100	4-Cl-EAPP	4-Cl-alpha-EAPP	1-(4-chlorophenyl)-2-(ethylamino)pentan-1-one	Y	N	N
101	4-Ethylethcathinone	4-EEC; 4-ethyl-N-ethylcathinone; 4-Ethylethcathinone; 1-Propanone, 2-(ethylamino)-1-(4-ethylphenyl)-	2-(ethylamino)-1-(4-ethylphenyl)propan-1-one	Y	Y	Y
102	4-Ethylmethcathinone	1225622-14-9, 4-EMC	1-(4-ethylphenyl)-2-(methylamino)propan-1-one	Y	Y	Y
103	4-ethylpentedrone	4-EPD	1-(4-ethylphenyl)-2-(methylamino)pentan-1-one	N	N	Y
104	4-fluoro-alpha-pyrolidinobutanophenone	4F-PBP; 4-F-PBP; fluoro-α-pyrrolidinobutyrophenone	4'-fluoro-α-pyrrolidinobutyrophenone	Y	Y	Y
105	4-fluoro-alpha-pyrrolidinohexanophenone	4-F-alpha-PHP; 4-fluoro-PHP; 4-F-PHP; 4’-fluoro-Pyrrolidinohexanophenone; 4-F-α-PHP	1-(4-fluorophenyl)-2-(pyrrolidin-1-yl)hexan-1-one	Y	Y	Y
106	4-fluoro-alpha-pyrrolidinovalerophenone	4-F-PVP; 850352-31-7 4F-alpha-PVP; 4f-a-pvp; pfpvp; 4’-Fluoro-α-pyrrolidinopentiophenone; 4F-PVP; FPVP; 4F-α-PVP; O-2370	1-(4-Fluorophenyl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y
107	4-fluoro-N-ethylbuphedrone	4F-NEB; 4-F-NEB; 4-fluoro-N-ethylbuphedrone	2-(Ethylamino)-1-(4-fluorophenyl)butan-1-one	Y	Y	Y
108	4-fluoro-N-ethylpentedrone	4F-NEP; 4-fluoro-N-ethylpentedrone; 4-F-NEP	4-fluoro-alpha-ethylaminopentiophenone	Y	Y	Y
109	4-fluorobuphedrone	4-Fluorobuphedrone; 4F-Buphedrone; 4-Fluoro-(methylamino)butyrophenone; 4F-MABP	1-(4-Fluorophenyl)-2-(methylamino)butan-1-one	Y	Y	N
110	4-Fluorocathinone	4-FC	2-amino-1-(4-fluorophenyl)propan-1-one	Y	Y	Y
111	4-fluoroethcathinone	4-FEC	2-(Ethylamino)-1-(4-fluorophenyl)propan-1-one	Y	Y	N
112	4-Fluoroisocathinone	4-FIC	1-amino-1-(4-fluorophenyl)propan-2-one	Y	N	N
113	4-Fluoromethcathinone	7589-35-7, Flephedrone, 4-FMC; Flephedrone; 4-Fluoromethcathinone; p-Fluoromethcathinone; 4F-MCAT.	1-(4-Fluorophenyl)-2-(methylamino)propan-1-one	Y	Y	Y
114	4-Fluorooctedrone		1-(4-fluorophenyl)-2-(methylamino)octan-1-one	Y	N	N
115	4-Hydroxy-3-methoxymethcathinone	916177-15-6; HMMC; Methylone-M2	1-(3-Hydroxy-4-methoxyphenyl)-2-(methylamino)propan-1-one	Y	N	Y

116	4-methoxy-alpha-pyrolidinoheptanophenone	4-methoxy-PHPP, 4-MeO-PV8, 4-MeO-alpha-PEP; 4-MeO-α-PV8; 4-MeO-α-PEP	4-methoxy-alpha-pyrrolidinoenanthophenone	Y	Y	Y
117	4-methoxy-alpha-pyrrolidinopropiophenone	4-Methoxy-alpha-PPP; MOPPP; pMPPP; 4′-Methoxy-α-pyrrolidinopropiophenone; MeOPPP	1-(4-Methoxyphenyl)-2-(pyrrolidin-1-yl)propan-1-one	Y	Y	Y
118	4-Methoxy-alpha-pyrrolidinovalerophenone	5537-19-9 (HCl) 4-MeO-alpha-PVP; MOPVP; 4-Methoxy-α-pyrrolidinopentiophenone; 4-MeO-α-PVP	1-(4-Methoxyphenyl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y
119	4-methoxy-N-ethylcathinone	bk-PMEA	2-(ethylamino)-1-(4-methoxyphenyl)propan-1-one	Y	N	N
120	4-Methoxy-N-methcathinone	530-54-1, bk-PMMA, PMMC, METHEDRONE; 4-Methoxymethcathinone; para-methoxymethcathinone; βk-PMMA; methoxyphedrine; 4-MeOMC; methedrone	1-(4-methoxyphenyl)-2-(methylamino)propan-1-one	Y	Y	Y
121	4-Methoxy-N,N-dimethylcathinone	1089307-23-2	2-(dimethylamino)-1-(4-methoxyphenyl)-1-propanone, monohydrochloride	Y	N	N
122	4-Methoxyethylcathinone		2-(Ethylamino)-1-(4-methoxyphenyl)-1-propanone	Y	N	N
123	4-Methyl-alpha-ethylaminobutiophenone	4-MEABP	2-(ethylamino)-1-(4-methylphenyl)-1-butanone, monohydrochloride	Y	N	N
124	4-Methyl-N-benzylcathinone	4-MBC, Benzedrone; 4-methyl-N-benzylcathinone; N-benzyl-4-methylcathinone; 1-(4-methylphenyl)-2-benzylaminopropan-1-one	(±)-1-(4-methylphenyl)-2-(benzylamino)propan-1-one	Y	Y	Y
125	4-methyl-N,N-diethylcathinone		2-(diethylamino)-1-(p-tolyl)propan-1-one	N	Y	Y
126	4-methyl-N,N-dimethylcathinone	4-MDMC	4-Methyl-N,N-dimethylcathinone	Y	Y	Y
127	4-Methyl-α-pyrrolidinobutiophenone	1214-15-9 (HCl) MPBP; 4'-Methyl-alpha-pyrrolidinobutyrophenone; 4-Methyl-α-pyrrolidinobutiophenone	(RS)-1-(4-methylphenyl)-2-(1-pyrrolidinyl)-1-butanone	Y	Y	Y
128	4-Methyl-α-pyrrolidinohexiophenone	4'-Methyl-alpha-pyrrolidinohexanophenone; MPHP; 4′-Methyl-α-pyrrolidinohexanophenone; 2-(Pyrrolidin-1-Yl)-1-(P-Tolyl)Hexan-1-One; 4′-Me-α-PHP; 4′-Me-PHP; PV4; α-PXP	1-(4-Methylphenyl)-2-(1-pyrrolidinyl)-1-hexanone	Y	Y	Y
129	4-Methyl-α-pyrrolidinopropiophenone	1313393-58-6; MPPP; 4'-methyl-alpha-PPP; 4-MePPP; MαPPP; 4-Methyl-alpha-PPP; MalphaPPP	Methyl-α-pyrrolidinopropiophenone	Y	Y	Y
130	4-Methylbuphedrone	4-MeMABP; 4-Me-MABP; βk-N-methyl-4-MAB; 4-Methylbuphedrone; N,4-Dimethylbuphedrone; 1-Butanone, 2-(methylamino)-1-(4-methylphenyl)-; 4-Methyl-alpha-methylamino-butyrophenone	2-(Methylamino)-1-(4-methylphenyl)butan-1-one	Y	Y	Y
131	4-Methyldiethcathinone	676316-90-8, 4-MDEC	2-(diethylamino)-1-(4-methylphenyl)-1-propanone, monohydrochloride	Y	N	N
132	4-Methylethcathinone	1225617-18-4, 4-MEC; 4-Methylethcathinone; 4-methyl-N-ethylcathinone; 2-ethylamino-1-p-tolylpropan-1-one; NRG-2	4-Methyl-N-ethylcathinone	Y	Y	Y
133	4-Methylmethcathinone	1189805-46-6; 4-MMC; Mephedrone; 4-methylmethcathinone; 4-methylmethcathinone; 4-MMC;	2-(methylamino)-1-(p-tolyl)propan-1-one	Y	Y	Y

		4-methyl ephedrone; Meow Meow; M-Cat; Drone; Bubbles; White Magic				
134	4'-ethyl-alpha-PVP		1-(4-ethylphenyl)-2-(pyrrolidin-1-yl)pentan-1-one	N	Y	N
135	4'-methyl-alpha-PiHP	4'-methyl-α-PHP; 4'-methyl PHP; MPHP; PV4	2-(pyrrolidin-1-yl)-1-(p-tolyl)hexan-1-one, monohydrochloride	N	Y	N
136	4'-methyl-NiPP		1-(4-methylphenyl)-2-(1-methylethylamino)pentan-1-one	N	Y	N
137	4F-alpha-PHiP	4F-α-PHiP; 4F-alpha-pyrrolidinoisohexanophenone; 4F-alpha-PiHP	1-(4-fluorophenyl)-4-methyl-2-pyrrolidin-1-yl-pentan-1-one	Y	Y	Y
138	5-dihydrobenzofuranpyrovalerone	5-DBFPV	5-dihydrobenzofuranpyrovalerone	Y	Y	Y
139	5-Methylethylone	5-me	2-(Ethylamino)-1-(7-methyl-1,3-benzodioxol-5-yl)-1-propanone	N	N	Y
140	a-Me-3-DESMETHYL	α-Me-3-DESMETHYL; 5-(2-Aminopropyl)-2,3-dimethoxyphenol	5-(2-Aminopropyl)-2,3-dimethoxyphenol	N	N	Y
141	alpha-Aminobutyrophenone	67323-52-8	2-amino-1-phenylbutan-1-one	Y	N	N
142	alpha-ethylaminopentiophenone	α-EAPP; N-ethylpentedrone, N-ethylnorpentedrone, NEP; Ethyl-Pentedrone; N-ethyl-(nor)-pentedrone; α-ethylaminopentiophenone	2-(Ethylamino)-1-phenyl-1-pentanone	Y	Y	Y
143	alpha-methylaminobutyrophenone	408332-79-6 MABP, Buphedrone; MABP; α-(Methylamino)butyrophenone; 1-Butanone, 2-(methylamino)-1-phenyl-; Alpha-Methylamino-butyrophenone;	2-(Methylamino)-1-phenylbutan-1-one	Y	Y	Y
144	alpha-PBT	α-Pyrrolidinobutiothiophenone; α-PBT	2-(pyrrolidin-1-yl)-1-(thiophen-2-yl)butan-1-one	N	Y	Y
145	alpha-phthalimidopropiophenone	19437-20-8; PAPP; A-Phthalimidopropiophenone	2-(1-oxo-1-phenylpropan-2-yl)isoindole-1,3-dione	Y	N	N
146	alpha-PVT	α-Pyrrolidinopentiothiophenone	2-(Pyrrolidin-1-yl)-1-(thiophen-2-yl)pentan-1-one	N	Y	Y
147	alpha-pyrolidinobutiophenone indane analogue	5-PPDi	1-(2,3-dihydro-1H-inden-5-yl)-2-(pyrrolidin-1-yl)butan-1-one	Y	Y	Y
148	alpha-pyrrolidinobutiophenone	α-PBP alpha-PBP; α-Pyrrolidinobutiophenone; α-PEP	1-Phenyl-2-(pyrrolidin-1-yl)butan-1-one	Y	Y	Y
149	alpha-pyrrolidinoheptiophenone	alpha-PEP, alpha-PHPP, PV8	1-phenyl-2-(pyrrolidin-1-yl)heptan-1-one	Y	Y	Y
150	alpha-pyrrolidinohexanophenone	alpha-PHP; α-PHP; 1-Phenyl-2-(pyrrolidin-1-yl)hexan-1-one	1-phenyl-2-(1-pyrrolidinyl)-1-hexanone, monohydrochloride	Y	Y	Y
151	alpha-pyrrolidinononaphenone	alpha-PNP; α-pyrrolidinononaphenone; PV-10; α-PNP	1-phenyl-2-(1-pyrrolidinyl)-1-nonanone	Y	Y	Y
152	alpha-pyrrolidinopropiophenone	19134-50-0; alpha-PPP; α-Pyrrolidinopropiophenone	(RS)-1-Phenyl-2-(1-pyrrolidinyl)-1-propanone	Y	Y	Y
153	beta-keto-N-methylbenzodioxolylbutanamine	17762-90-2; bk-MBDB; butylone; B1; βk-MBDB; β-keto-N-methylbenzodioxolylbutanamine; MDMBP; 2-methylamino-1-(3,4-methylenedioxyphenyl)butan-1-one	1-(1,3-benzodioxol-5-yl)-2-(methylamino)butan-1-one	Y	Y	Y
154	beta-keto-N-methylbenzodioxolylpentanamine	698963-77-8, bk-MBDP, bk-Methyl-K, Pentylone; βk-{N-	1-(2H-1,3-Benzodioxol-5-yl)-2-	Y	Y	Y

		methyl-1-(1;3-benzodioxol-5-yl)-2-pentanamine; βk-Methyl-K, βk-MBDP, methylenedioxypentedrone; MDMVP; 1-(1,3-Benzodioxol-5-yl)-2-(methylamino)pentan-1-one	(methylamino)pentan-1-one			
155	beta-keto-N,N-dimethylbenzodioxolylbutanamine	bk-DMBDB; bk-MMBDB; Dibutylone; Methylbutylone; m-butylone; N-methylbutylone; butylone ME; βk-DMBDB; 1-(Benzo[d][1,3]dioxol-5-yl)-2-(dimethylamino)butan-1-one; β-Keto-dimethylbenzodioxolylbutanamine; MDDMBP	1-(1,3-Benzodioxol-5-yl)-2-(dimethylamino)butan-1-one	Y	Y	Y
156	BK-MPA	MTP, THIOTHINONE	2-(methylamino)-1-(thiophen-2-yl)propan-1-one	N	N	Y
157	BuONE	1-(2H-1,3-Benzodioxol-5-yl)-2-(butylamino)propan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-(butylamino)propan-1-one	N	N	Y
158	Bupropion	Amfebutamone	2-(tert-butylamino)-1-(3-chlorophenyl)propan-1-one	N	Y	N
159	Cathinone	D-Cathinone; benzoylethanamine; β-ketoamphetamine; (−)-cathinone; Norephedrone, racemic mixture.	(S)-2-Amino-1-phenyl-1-propanone	N	N	Y
160	Cyclohexane analogue of mephedrone		2-(methylamino)-1-(4-methylcyclohexyl)propan-1-one	N	N	Y
161	DEONE	N,N-Diethyl MDCATH; N,N-Diethyl MDCATH; N,N-Diethyl-3,4-methylenedioxycathinone; N,N-Diethyl-b-keto-3,4-methylenedioxyamphetamine;	1-(2H-1,3-Benzodioxol-5-yl)-2-(diethylamino)propan-1-one	N	N	Y
162	Dimethoxymethcathinone	2,5-DMOMC	1-(2,5-dimethoxyphenyl)-2-(methylamino)propan-1-one	Y	N	N
163	Dimethylcathinone	15351-09-4; Metamfepramone; Dimethylcathinone; Dimethylpropion; N,N-DMC; Dimepropion; rakefet	2-(dimethylamino)-1-phenylpropan-1-one	Y	Y	Y
164	DOMC	N-MMC, 2-(Methoxy-methyl-amino)-1-(2-methoxy-phenyl)-propan-1-on	2-(Methoxy-methyl-amino)-1-(2-methoxy-phenyl)-propan-1-one	N	N	Y
165	Ephylone	βk-Ethyl-K; βk-EBDP Crystals; (benzo[d][1,3]dioxo1-5-y1)-2-(ethylamino)pentan-1-one; β-Keto-3,4-methylenedioxy-alpha-propyl-N-ethyl-phenethylamine; ETHYL-K; N-Ethylnorpentylone	2-ethylamino-1-(3;4-methylenedioxyphenyl) pentan-1-one	Y	Y	Y
166	Ethcathinone	51553-17-4; Ethylpropion; EC, Ethyl cathinone; Ethcathinone; ETH-CAT; Ethylpropion; E-Cat; EAP; NEC; N-Ethylaminopropiophenone; LYMHIBZGTAPASQ-UHFFFAOYSA-N; 18259-37-5; CHEMBL3298876; 1-Phenyl-2-(ethylamino)-1-propanone; Ethylcathinone	2-(Ethylamino)-1-phenylpropan-1-one	Y	Y	Y
167	Ethylnaphthidate	HDEP-28	Ethyl 2-naphthyl(2-piperidinyl)acetate	Y	N	N
168	Ethylone	1112937-64-0 bk-MDEA, MDEC; EtONE; βk-MDEA; 3,4-methylenedioxy-N-ethylcathinone; 2-ethylamino-1-(3,4-	(RS)-1-(1,3-benzodioxol-5-yl)-2-(ethylamino)propan-1-one	Y	Y	Y

		methylenedioxyphenyl)propan-1-one				
169	Eutylone	17764-18-0 ; MDEBP; βk-EBDB; N-Ethylbutylone; β-Keto-ethylbenzodioxolylbutanamine	β-Keto-1,3-benzodioxolyl-N-ethylbutanamine	Y	Y	Y
170	Hexedrone	β-propylmethcathinone; B-Propylmethcathinone	2-(methylamino)-1-phenylhexan-1-one	Y	Y	Y
171	i-PAP	2-isopropylamino-1-phenyl-propan-1-one; 2-isopropylamino-1-phenyl-propan-1-one; 1-phenyl-2-(propan-2-ylamino)propan-1-one; Alpha-Iso-propylaminopropiophenone	1-Phenyl-2-[(propan-2-yl)amino]propan-1-one	N	N	Y
172	iBuONE	1-(2H-1,3-Benzodioxol-5-yl)-2-[(2-methylpropyl)amino]propan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-[(2-methylpropyl)amino]propan-1-one	N	N	Y
173	Indanyl-alpha-pyrolidonohexanophenone	5-BPDI	1-(2,3-dihydro-1H-inden-5-yl)-2-(pyrrolidin-1-yl)hexan-1-one	Y	Y	Y
174	Iso-ethcathinone		(±)-1-ethylamino-1-phenyl-propan-2-one	Y	N	Y
175	Iso-pentedrone		1-(methylamino)-1-phenylpentan-2-one	Y	N	Y
176	Iso-pentylone	1-(1,3-Benzodioxol-5-yl)-1-(methylamino)pentan-2-one	1-(2H-1,3-Benzodioxol-5-yl)-1-(methylamino)pentan-2-one	Y	N	N
177	MDBVP	bk-bbdp; βk-BBDP; 1-(2H-1,3-Benzodioxol-5-yl)-2-(butylamino)pentan-1-one	1-(1,3-Benzodioxol-5-yl)-2-(butylamino)pentan-1-one	N	N	Y
178	MDDEBP	1-(2H-1,3-Benzodioxol-5-yl)-2-(diethylamino)butan-1-one	1-(1,3-Benzodioxol-5-yl)-2-(diethylamino)butan-1-one	N	N	Y
179	MDDEHP	1-(2H-1,3-Benzodioxol-5-yl)-2-(diethylamino)hexan-1-one;	1-(1,3-Benzodioxol-5-yl)-2-(diethylamino)hexan-1-one	N	N	Y
180	MDDEVP	N,N-Diethylpentylone; N,N-Diethylpentylone; 1-(1,3-Benzodioxol-5-yl)-2-(diethylamino)pentan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-(diethylamino)pentan-1-one	N	N	Y
181	MDDMHP	1-(1,3-Benzodioxol-5-yl)-2-(dimethylamino)hexan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-(dimethylamino)hexan-1-one	N	N	Y
182	MDIPBP	1-(1,3-Benzodioxol-5-yl)-2-(propan-2-ylamino)butan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-[(propan-2-yl)amino]butan-1-one	N	N	Y
183	MDIPVP	1-(1,3-Benzodioxol-5-yl)-2-(propan-2-ylamino)pentan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-[(propan-2-yl)amino]pentan-1-one	N	N	Y
184	MDPVP	1-(1,3-Benzodioxol-5-yl)-2-(propylamino)pentan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-(propylamino)pentan-1-one	N	N	Y
185	MDSBVP	1-(1,3-Benzodioxol-5-yl)-2-(butan-2-ylamino)pentan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-[(butan-2-yl)amino]pentan-1-one	N	N	Y
186	Methcathinone	Methcath; Ephedrone; Jee Cocktail; monomethylpropion; CAT; jeff; catnip; intash; Snow Blow; 2-(Methylamino)propiophenone; Alpha-Methylaminopropiophenone; 1-PROPANONE, 2-	2-(Methylamino)-1-phenylpropan-1-one	N	N	Y

		(METHYLAMINO)-1-PHENYL-; LPLLVINFLBSFRP-UHFFFAOYSA-N; N-Methylcathinone; EINECS 227-092-7; methylaminopropiophenone; AC1L1BRO; DivK1c_000966; SCHEMBL497486; alpha-N-Methylaminopropiophenone; DEA No. 1237; BDBM86285; KBio1_000966; NINDS_000966; CAS_1576; NSC_1576; AL-422; AL-463; AL-464; 5650-44-2; 2-(Methylamino)-1-phenylpropan-1-one; 2-Methylamino-1-phenylpropanone; 2-(Methylamino)-1-phenyl-1-propanone; alpha.- alpha-(Methylamino)propiophenone; 1-phenyl-2-methylamino-1-propanone; 2-(Methylamino)-1-phenyl-1-propanone #; 2-Methylamino-1-phenyl-1-propanone				
187	Methylone	196028-79-5 bk-MDMA; βk-MDMA; M1; MDMC; 3,4-methylenedioxy-N-methylcathinone; MDMCAT; MDMC ; Explosion; Room odorizer vanilla; Inpact	(RS)-1-(benzo[d][1,3]dioxol-5-yl)-N-methylpropan-2-amine	Y	Y	Y
188	Methylone Hydrochloride	2-Methylamino-1-(3,4-methylenedioxyphenyl)propan-1-one; 1-benzo[1,3]dioxol-5-yl-2-methylamino-propan-1-one hcl; 2-Methylamino-1-(3,4-methylenedioxyphenyl)propan-1-one	1-(1,3-benzodioxol-5-yl)-2-(methylamino)propan-1-one;hydrochloride	N	N	Y
189	Methylone-M1	MHMC	1-(4-Hydroxy-3-methoxyphenyl)-2-(methylamino)propan-1-one	N	N	Y
190	Mexedrone	4-MMC-oMe; MEX	3-methoxy-2-(methylamino)-1-(p-tolyl)propan-1-one	Y	Y	Y
191	N-acetyl methylone		N-(1-(benzo[d][1,3]dioxol-5-yl)-1-oxopropan-2-yl)-N-methylacetamide	Y	N	N
192	N-acetyl-3-methylmethcathinone	N-Ac-3-MMC	N-methyl-N-(1-oxo-1-(m-tolyl)propan-2-yl)acetamide	Y	N	N
193	N-Acetyl-N-Methyl-3,4-Methylenedioxycathinone		N-(1-(benzo[d][1,3]dioxol-5-yl)-1-oxopropan-2-yl)-N-methylacetamide	Y	N	N
194	N-Allylmethylone		1-(2H-1,3-Benzodioxol-5-yl)-2-[methyl(prop-2-en-1-yl)amino]propan-1-one	Y	N	N
195	N-butylhexedrone		2-(butylamino)-1-phenylhexan-1-one	N	Y	N
196	N-butylpentylone		1-(1,3-benzodioxol-5-yl)-2-(butylamino)pentan-1-one	N	Y	N
197	N-Ethyl hexylone	2-ETHYL-1,3-HEXANEDIOL; 94-96-2; Ethohexadiol; 2-Ethylhexane-1,3-diol; 1,3-Hexanediol, 2-ethyl-; Octylene glycol; Ethyl hexanediol; Carbide 6-12; Repellent 612; Rutgers 612; 6-12-Insect repellent; Diol-Kyowa 8; 2-Ethyl-3-propyl-1,3-propanediol; 2-Ethyl-1,3-hexylene glycol; 3-Hydroxymethyl-n-heptan-4-ol;	1-(1,3-benzodioxol-5-yl)-2-(ethylamino)-1-hexanone	N	N	Y

		2-Ethyl-1,3-hexandiol; Ethylhexylene glycol; ENT 375; Ethohexadiol [USP]; Caswell No. 445; 6-12 insect repellent; Latka 612 [Czech]; NSC 3881; CCRIS 4034; Ethyl hexylene glycol; Compound 6-12 insect repellent; HSDB 1716; 2-Ethylhexanediol-1,3; EINECS 202-377-9; EPA Pesticide Chemical Code 041001; BRN 1735324; AI3-00375; CHEBI:34273; Compound 6-12, insect repellent; RWLALWYNXFYRGW-UHFFFAOYSA-N; MFCD00004578; NCGC00091575-01; DSSTox_CID_5292; DSSTox_RID_77729; DSSTox_GSID_25292; etohexadiol; CAS-94-96-2; Latka 612; 2-Ethyl-1,3-hexanediol, 99%, mixture of isomers; ethohexadiol(r); EH diol; AC1Q2UNQ; EC 202-377-9; 2-ethyl-1,3-hexane diol; 2-ethyl-hexane-1,3-diol; Ethyl-1,3-hexane diol-2; SCHEMBL38007; 4-01-00-02597 (Beilstein Handbook Reference); AC1L1O97; WLN: QY3&Y2&1Q; CHEMBL1451179; DTXSID4025292; CTK3I9637; NSC3881; MolPort-000-255-071; KS-000011NS; NSC-3881; Tox21_111152; Tox21_202003; Tox21_303253; ANW-42033; SBB060488; AKOS002313502; AKOS016051411; Tox21_111152_1; FCH1112885; LS-1969; MCULE-4462593004; RTR-033135; NCGC00091575-02; NCGC00091575-03; NCGC00256943-01; NCGC00259552-01; AK116710; AN-24302; CC-10478; KB-23711; S173; TR-033135; 2-Ethyl-1,3-hexanediol, analytical standard; E0119; FT-0612228; ST24022226; ST50759403; C14271; C-33909; SR-01000944444; 2-Ethyl-1,3-hexanediol, 97%, Mixture of isomers; I14-0598; SR-01000944444-1; BRD-A55455283-001-01-3; InChI=1/C8H18O2/c1-3-5-8(10)7(4-2)6-9/h7-10H,3-6H2,1-2H; 1321-34-2				
198	N-Ethylbuphedrone	NEB; NEB; 1-Butanone, 2-(ethylamino)-1-phenyl-	2-(Ethylamino)-1-phenylbutan-1-one	Y	Y	Y
199	N-ethylbuphedrone indane analogue	βk-IBP; bk-IBP, NEB indane analogue; 2-(ethylamino)-1-(indan-5-yl)butan-1-one; 3,4-Propano-alpha-(ethylamino)butyrophenone	1-(2,3-Dihydro-1H-inden-5-yl)-2-(ethylamino)butan-1-one	Y	Y	Y
200	N-ethylheptedrone		2-(ethylamino)-1-phenylheptan-1-one	N	Y	N
201	N-ethylhexedrone	NEH, HEXEN; Ethyl-Hexedrone Powder; α-ethylaminocaprophenone; N-ethylnorhexedrone; hexen; NEH; N-Ethylhexedrone; Ethyl-Hexedrone Powder	2-(ethylamino)-1-phenylhexan-1-one	Y	Y	Y

202	N-methyl-bk-MMDA-2	N-methyl-βk-MMDA-2; 2-methylamino-1-(2-methoxy-4;5-methylenedioxyphenyl)propan-1-one; 1-Propanone, 1-(6-methoxy-1,3-benzodioxol-5-yl)-2-(methylamino)-	1-(6-Methoxy-1,3-benzodioxol-5-yl)-2-(methylamino)-1-propanone	N	Y	Y
203	N-methyl-bk-MMDA-5	5-methoxy-methylone; 5-methoxymethylone; 2A1M-P; βk-MMDMA; N-methyl-βk-MMDA-5	1-(7-methoxy-1,3-benzodioxol-5-yl)-2-(methylamino)propan-1-one	Y	Y	Y
204	N-methylbenzedrone	1-propanone; 1-(4-methylphenyl)-2-[methyl(phenylmethyl)amino]-; 2-(benzylmethylamino)-4-methylpropiophenone	2-[Benzyl(methyl)amino]-1-(4-methylphenyl)propan-1-one	Y	Y	Y
205	Naphthylpyrovalerone	850352-53-3 O-2482; Naphyrone; NRG-1; O-2482; Energy 1	1-(naphthalen-2-yl)-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y
206	NEiH	alpha-ethylaminoisohexiophenone	2-(ethylamino)-4-methyl-1-phenyl-pentan-1-one; N-ethyl-isohexedrone	Y	Y	Y
207	NiPH	1-phenyl-2-(1-methylethylamino)hexan-1-one; 1-phenyl-2-(isopropylamino)hexan-1-one; 2-(isopropylamino)-1-phenylhexan-1-one; N-isopropylhexedrone	2-[(1-methylethyl)amino]-1-phenyl-1-hexanone	Y	Y	Y
208	Nor-mephedrone	4-methylcathinone; 4-MC; Nor-mephedrone; Normephedrone	2-amino-1-(4-methylphenyl)propan-1-one	Y	Y	Y
209	PBAI	5-Bromo-2,3-dihydro-1H-inden-2-amine; 5-Bromo-2,3-dihydro-1H-inden-2-amine	(2R)-5-bromo-2,3-dihydro-1H-inden-2-amine	N	N	Y
210	Pentedrone	879669-95-1, ß-ethyl-methcathinone; Drone; Alpha-methylamino-valerophenone; A-methylamino-valerophenone; β-ethyl-methcathinone	2-(Methylamino)-1-phenylpentan-1-one	Y	Y	Y
211	PIAP	1-Phenyl-2-(piperidin-1-yl)propan-1-one	1-Phenyl-2-(piperidin-1-yl)propan-1-one	N	N	Y
212	Propylcathinone	Propylcathinone; N-propylcathinone; N-mono-n-propylcathinone; PC; PAP	1-Phenyl-2-(propylamino)propan-1-one	Y	Y	Y
213	Propylone	bk-3,4-MDPA; PRONE; Propyl-3,4-methylenedioxycathinone	3,4-methylenedioxy-N-propylcathinone	Y	Y	Y
214	Pyrophenidone	α-Phenyl-Pyrovalerone	2-phenyl-2-(pyrrolidin-1-yl)-1-(p-tolyl)ethanone	N	N	Y
215	Pyrovalerone	Centroton, 4-Methyl-β-keto-prolintane, Thymergix, O-2371; Centroton; 4-Methyl-β-keto-prolintane; Thymergix; O-2371	(RS)-1-(4-methylphenyl)-2-(1-pyrrolidinyl)pentan-1-one	N	N	Y
216	PZAP		2-(4-Methylpiperazin-1-yl)-1-phenylpropan-1-one	N	N	Y
217	sBuONE	1-(1,3-Benzodioxol-5-yl)-2-(butan-2-ylamino)propan-1-one	1-(2H-1,3-Benzodioxol-5-yl)-2-[(butan-2-yl)amino]propan-1-one	N	N	Y
218	t-BAP	2-(N-tert-Butylamino)propiophenone	2-[(2-Methyl-2-propanyl)amino]-1-phenyl-1-propanone	N	N	Y
219	TH-PBP		2-(Pyrrolidin-1-yl)-1-(5,6,7,8-tetrahydronaphthalen-2-yl)butan-1-one	Y	Y	N
220	α-Propylaminopentiophenone	N-Propylpentedrone; N-propylnorpentedrone; 2-propylamino-1-phenylpentanone; 2-(propylamino)-valerophenone; alpha-propylaminopentiophenone	1-Phenyl-2-(propylamino)pentan-1-one	Y	Y	Y

221	α-pyrrolidinoisohexanophenone	α-PHiP, α-PiHP, alpha-PHiP; 4-me-PVP; 4M-PVP; α-pyrrolidinoisohexiophenone	4-methyl-1-phenyl-2-(1-pyrrolidinyl)-1-pentanone	Y	Y	Y
222	α-pyrrolidinovalerophenone or alpha-Pyrrolidinovalerophenone	14530-33-7 α-PVP, O-2387, alpha-PVP; Flakka, O-2387; b-ketone-prolintane; Prolintanone; alpha-pyrrolidinovalerophenone; alpha-pyrrolidinovalerophenone; Desmethyl pyrovalerone; Alpha-Pyrrolidinopentiophenone; 2pyrrolidin-1-yl-1-phenylpentan-1-one; 1-Pentanone, 1-phenyl-2-(1-pyrrolidinyl)-; Gravel; alpha-PVP	1-Phenyl-2-(pyrrolidin-1-yl)pentan-1-one	Y	Y	Y

Appendix 2: Synthetic cathinones listed in the NPSfinder®; UNODC; and EMCDDA databases.

List of Hyperlinks for Crosschecking

amphetamines

Cocaine

MDMA

DAT

NET

SERT

Methamphetamine

NE

5-HT

Methamphetamine

DA

GABA-A

GABA-B

diazepam

midazolam

lorazepam

haloperidol

olanzapine

ziprasidone