Carfentanil advertised on the darknet: scam or public health threat?

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Abstract

Background: In an age of global insecurity, the availability of highly potent synthetic drugs has been facilitated by surface web, darknet markets and social media fuelling various types of new criminal activities and their growth in sophistication. This study presents a systematic analysis of the darknet sale of one of the most potent synthetic opioids: Carfentanil. With an equianalgesic potency of 10.000 times a unit of morphine, its toxicity is comparable to traditional nerve agents, and it has been previously used as a chemical weapon, causing human fatalities. **Methods:** Digital trace data was collected retrospectively from all the darknet marketplaces, which have been active in the past five years. Data on vendors offering Carfentanil on Agartha, Empire and Yakuza marketplaces were analysed with regard to items

sold and sellers' features as these were the only active markets at the time of search. Searches were carried out in the English language only. **Results:** 63 different Cartfentanil vendors operating on 19 darknet marketplaces were identified. Contacts and payments were facilitated with end-to-end encryption messaging mobile applications and content-expiring messages. Although Agartha was mainly identified as a scam market, and no operative sellers were found on Yakuza, sellers of Carfentanil were active in Empire marketplace, with a number of transaction ranging from 4 to 1223. **Conclusion:** The availability of highly potent drugs such as Carfentanil on the darknet requires the urgent development of innovative scientific methods able to monitor and to predict such new threats, while informing policymaking and influencing darknet market's internal regulations to protect the health and the security of citizens.

Keywords:
Carfentanil; Synthetic Opioids; Darknet; Novel Psychoactive Substances; Chemical Weapon

Introduction

Background

In an age of global insecurity, various psychoactive substances have been used as performance enhancers in war scenarios and in terrorist attacks (Al-Imam et al. 2016; van Hout et al. 2016; King et al 2011). Cases of individuals injuring others under the effects of drugs have been destabilizing parts of West Africa, the Gaza strip, among other regions, where psychoactive substances have been used by terror groups in order to finance their other illicit activities, or to facilitate them in case of drug-induced suicide bombing (Progler, 2010, UNODC 2019). Most of these drugs are available for sale on the web and more recently on the darknet, fuelling various types of new criminal activities and their growth in sophistication.

These include a wide range of newly developed, or previously unknown chemical, pharmaceutical, and herbal drugs, known as New Psychoactive Substances (NPS), posing serious challenges for public health and safety and making this phenomenon even more likely to expand in the nearest future (Schifano et al., 2015; Corazza and Roman-Urrestarazu, 2017). The EU Early Warning System now monitors more than 730 new substances, with over 55 of these identified for the first time in 2018 (EMCCDA-EUROPOL, 2019). By December 2018, 119 countries and territories had reported over 899 NPS to the UNODC 'Global Synthetics Monitoring: Analysis, Reporting and Trends (SMART) Programme', far exceeding the 234 substances currently scheduled under the International Drug Control Conventions (UNODC, 2019). Of particular concern are the New Synthetic Opioids (NSO), a heterogenous class of highly potent opioids and other compounds with opioid-like effects, which are currently fueling one of the major drug related crisis in human history in North America and other countries, mainly due to the over-prescription of opioid analgesics (National Institute on Drug Abuse 2019; UNODC 2019; Hadland & Beletsky, 2018).

NSO include fentanyl analogues and other structurally distinct non-fentanyl compounds, such as the benzamide opioids AH-7921, U-47700, U-77891, U-50488, bromadoline and piperazine opioids, such as MT-45, and W-18, which pose significant life-threatening risks including overdose, respiratory arrest, risk of infectious diseases (HIV, or Hepatitis C), severe dependence and death (UNODC 2019). The majority of such substances have been developed as 'research chemicals' and have not been approved for human use due to their potency, while some have been employed in human anesthesia or in veterinary medicine for the sedation of large size animals. NSO are stronger than classical opioids and more

dangerous, as acute toxicity manifests itself at the tens of microgram level and their potency exceeds by several orders of magnitude that of classical opioids (e.g. Carfentanil is 10,000 times as potent as a unit of morphine).

Some NSO have been evaluated for pharmacokinetic parameters, including potency, binding affinity to mu-, delta-, and kappa-opioid receptors, or receptor efficacy: they are used in both human and veterinary clinical settings, as they present greater analgesic potency and may cause fewer side effects than morphine in terms of cardiovascular and respiratory functions when administered under medical supervision. However, their facile syntheses and low prices have led to development of over 1,400 other fentanyl analogues (Armenian et al., 2017; Misailidi et al., 2018). Originally designed to mimic fentanyl's opioid effects, these are by far the most dangerous NSO, many of which have never been studied in humans. It has also been argued that the toxicity of some of the fentanyl analogues, such as Carfentanil, is so high that they are comparable to traditional nerve agents and could be used as chemical weapons (Kinezt and Butler 2016). Forms of fentanyl were employed in an unsuccessful 1997 attempt by Mossad agents to kill a Hamas leader in Jordan by spraying the compounds in his ear (Kinezt and Butler 2016), and traces of a mixture of Carfentanil and Remifentanil were found in the clothing and the urine of two survivors following the Russian Special Forces' chemical attack against Chechen separatists in the Dubrovka theatre in 2002, which caused 125 fatalities (Riches et al 2012).

NSOs, such as Carfentanil and the longer-acting Lofentanil (3-methyl-Carfentanil) or Ohmefentanyl (β- hydroxy-3-methylfentanyl), have relatively low production costs and their potency makes them highly lucrative, as small quantities which are easier to transport, may represent thousands of individual and potentially fatal doses. Risks increase if suppliers use NSOs to replace or supplement traditional opiates (ACMD, 2020).

Carfentanil pharmacology and toxicological profile

Synthesized in 1974 as a typical opioid agonist, Carfentanil (4-[{1-oxopropyl}-phenyl-amino]-1-[2- phenylethyl]-4-piperidinecarboxylic acid methyl ester), was approved in 1986 as a tranquilizer for large animals in veterinary settings at doses ranging from 5 to 20 μg/kg (George et al., 2010). Due to its potency and pharmacological features, it is not approved for human use, except for experimental research aimed to map opioid receptors with Positron Emission Tomography (PET) (Frost et al., 1989). During its development and use, research

evidenced some unique properties: for instance, it can be produced in odorless powder (as a free base) and liquid forms (as a salt), enabling the creation of organoleptically untraceable mixtures with a vast number of drugs and adulterants (Elliot et al., 2018). This, among other features, may account for its stable presence in the list of pseudo-legal "research chemicals" produced and distributed by a myriad of mainly Asian based clandestine laboratories to the markets of USA, Canada, Europe, Australia. Routes of administration range from oral, nasal insufflation, intravenous, intramuscular, transmucosal and transdermal through skin absorption (Prekupec et al., 2017). Carfentanil's pharmacological features are not completely disclosed, as the majority of information derives from animal or *in vitro* research or from anecdotal case reports of severe intoxication. It has been reported that it requires approximately 5.7 hours to decrease to half of its starting dose in the body (half-life) and 11.8 hours for its metabolite norcanfentanil (Uddayasankar et al., 2018). Furthermore, due to its high lipophilicity and high protein binding, Carfentanil shows a large distribution volume, which may account for the phenomena of "re-narcotization" (i.e. the recurrence of toxicity after stabilization) (Leen & Juurlink, 2019).

Current PET studies show that Carfentanil is about 10,000 times more potent than morphine, 4,000 times more than heroin, twice as potent as sufentanil and 20 times more potent than fentanyl (Shafer, 2019). This information contrasts with what is frequently stated as Carfentanil being 100-fold more potent than fentanyl (Pubchem, 2019). Nevertheless, studies report that its equilibrium dissociation constant (Ki) for opioid receptors (μ, κ, δ) are significantly lower than those for fentanyl (Leen & Juurlink, 2019), meaning that Carfentanil shows a higher affinity for such receptors. At post-mortem, typical levels of morphine in blood associated with fatalities are in excess of 50 ng/ml, for fentanyl greater than 3 ng/ml and for Carfentanil greater than 0.1 ng/ml (ACMD, 2020). Thus, a lethal dose of the substance ranges around 50μg, meaning that one kg might have the potential to cause up to 20 million associated fatal intoxications.

The expert board within the framework of the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) risk assessment procedures underlines the dangers caused by unintentional exposure to Carfentanil during its manufacturing and delivering. Despite the fact that Carfentanil toxicity is related to opioid toxidrome with rapid sedation, dizziness and severe respiratory depression, an accurate risk profile is not yet understood by clinicians. The majority of Carfentanil related deaths are associated with pulmonary oedema, congestion, aspiration of gastric contents (Solimini et al., 2018), cardiac and liver abnormalities. Nevertheless, a precise

assessment of Carfentanil induced toxicity is lacking in clinical practice, principally due to possible combinations of poisoning substances and to limited capacities of laboratory identification. The long-term effects as well as the abuse and the addiction potentials of Carfentanil have also been poorly studied on the basis of speculative projections on its toxicodynamic properties. Its dose-effects are only described on animal models and barely estimated for antidotal implications. Current standard treatments for Carfentanil's intoxications are similar to those for any opioid substances, ranging from oxygenic therapy, non-specific physiological support and antidote (Naloxone) administration (Irvine et al., 2018; Fairbairn et al., 2017).

Carfentanil's high level of toxicity in humans is further demonstrated by hundreds of fatal episodes across the US, Europe and the UK. Since its detection in Latvia in 2013, the substance was associated to 61 fatalities in 8 countries in the EU with 50% of them involving mixtures with other opioid such as heroin (EMCDDA, 2019; Elliott et al., 2018). In the UK, estimates provided by the National Programme on Substance Abuse Deaths (NPSAD) on fatalities related to fentanyl derivatives included Carfentanil as the most common substance in 55 cases although often in combination with other opioids and drugs of misuse, which further enhance the risk of death (ACMD, 2020). Considering that testing for NSO is not always required in presence of opioid overdoses, such evidence might be an underestimation of the overall phenomenon. In fact, a retrospective toxicological analysis in 2017 on 97 samples of urine and blood from heroin users revealed the presence of Carfentanil in 25 of these, alone or in combination with other derivatives such as butyrylfentanyl (Hikin et al., 2018). Overall, the expansion in the illicit drug market of these highly potent opioids, such as Carfentanil, has been seen as an iatrogenic effect of the "iron law of prohibition", which has focused over the years on suppression of access to drugs, leaving marginal attention to prevention and harm reduction activities (Beletsky & Davis, 2017; Martin, Cunliffe, Décary-Hétu, & Aldridge, 2018).

Darknet availability of Carfentanil

Darknet marketplaces and encryption techniques have been identified as important enablers of the illicit drug supply chain in contemporary societies, with the 2019 European Drug Report citing this as a major law enforcement challenge (EMCCDA 2019). With respect to NSOs' potential use as chemical weapons, Shafer (2019) commented that "on a per kilogram basis, Carfentanil is arguably 2000 times deadlier than a thermonuclear bomb". This appears particularly perturbing in today's ever-increasing digitalised drug markets. Both the surface

web and darknet markets are used for online drug sales, as are social media and mobile communication apps to advertise and facilitate the delivery of NPS to consumers. Since the first anonymous online drug market Silk Road was revealed in 2011 (Barrett, 2012), encrypted and anonymised transactions in cryptocurrency, hosted by the Tor anonymous browser, have reduced the need for more complex and easily detectable infrastructures traditionally needed for drug trafficking across borders (Demant et al., 2019; EMCDDA-EUROPOL, 2019; Griffiths et al., 2010; Martin). This has created an immense opportunity for Organised Crime Groups (OCG) to create more sophisticated business models, which generate new challenges for law enforcement and public health.

It has been estimated that since the shutdown of Silk Road in 2013, transaction via cryptomarkets have tripled, and revenues have doubled in less than three years (Kruithof et al., 2016). It has been estimated that four of the major darknet markets at the time (Dream Market, Berlusconi Market, Valhalla and TradeRoute) generated revenues of EUR 800,000 per day on average between July 2017 and August 2018 (EMCDDA-EUROPOL, 2019). And these markets continues to be dynamic and evolving. New chemicals, pharmaceutical, and herbal drugs continually appear with various large and smaller secondary markets rising and disappearing due to law enforcements, voluntary closure or exit scams. Although a variety of darknet marketplaces have agreed not to sell potentially dangerous psychoactive substances or prescription drugs in response to the opioid crisis (IDPC, 2018), we decided to carry out an investigation on the availability of Carfentanil on the darknet, while (i) identifying products availability; (ii) profiling vendors and their activity as this could be an alarming threat for the health and security of citizens. As far as we know, this is the first study of this kind.

Methods

Digital trace data was collected from prominent darknet marketplaces, using a proprietary threat intelligence platform provided by CyberSolace, a private sector company specialising in information security advisory services. The platform is primarily used for threat intelligence and provides monitoring of the darknet and deepweb by performing specific searches for different marketplaces, vendors and items. The ‘search spiders’, developed using Python scripts, allow a rapid scanning of the darknet as well as a retrospective analysis of marketplaces which no longer exist due to law enforcement operations or exit scams. This is an advantage compared to Tor or other browsers been used so far for these types of searches. Automated searches on the platform were carried out in July-August 2020 and included activities over the

past five years (1st January 2015 – 1st January 2020). The keyword used was "Carfentanil" or "Carfentanyl". Results were manually filtered and validated through searches on darknet dedicated online sources, which verified the activity and the reliability of marketplaces. Active marketplaces were further investigated using the Tor browser in order to detect potential scams. When availability, data on vendors' level/trust, date of account creation, last login, number of completed transactions, items sold, encryption type and origin were collected, to contribute in identifying scam and 'legitimate' accounts. Searches were carried out in the English language. The study was approved by the Human Sciences Ethics Committee at the University of Hertfordshire (HSK/SF/UH/00104).

Results

Markets, products, availability and restrictions

Overall 181 listings for Carfentanil were identified. These were sold by 72 vendors across 19 different marketplaces. These were Agartha, DreamAlt, Yakuza, Abraxas, Acropolis, Agora, Alphabay, Berlusconi, Crypto, Darkbay, Dream, Evolution, Sikkitien, Sill Road, Tchka, Tochka, Valhalla, Europa and Empire market. Among these, only 3 (Agartha, Yakuza and Empire) were listed as active, while all the others were inoperative at the time of the search. Some vendors were active in more than one market and duplicates were manually removed. Thus, a total of 63 different vendors was considered for further analysis. The overall number of listings and vendors for each marketplace has been summarised in Table 1.

Table 1: Marketplaces identified by automatized darknet search

Marketplace	No. of listings	No. of Vendors	Last posted on	Active/Defunct	Notes
Agartha	21	9	26/01/2020	Active	
DreamAlt	19	1	29/10/2019	Defunct	*not accessible on 04/08/2020
Yakuza	7	5	20/07/2020	Active	
Abraxas	5	1	14/10/2015	Defunct	
Acropolis	10	1	10/10/2016	Defunct	
Agora	2	1	26/11/2017	Defunct	
Alphabay	1	1	13/06/2017	Defunct	

Berlusconi	40	13	29/05/2019	Defunct	
Crypto	3	1	07/01/2016	Defunct	
Darkbay	1	1	19/09/2019	Defunct	
Dream	1	1	21/12/2017	Defunct	
Evolution	7	1	03/01/2015	Defunct	
Sikkitien	11	2	14/02/2019	Defunct	
Silk Road	1	1	25/09/2019	Defunct	
Tchka	12	10	20/10/2018	Defunct	
Tochka	15	10	26/11/2019	Defunct	
Valhalla	8	2	07/09/2018	Defunct	
Europa	3	2	27/03/2020	Defunct	
Empire market	14	9	N/A	Active	

Although some of the studied marketplaces declared a ban on dangerous products or drugs (e.g. fentanyl and its derivatives, MDPV, crack cocaine, heroin, scopolamine), it was clear that this internal regulation lacked consistency and that vendors were able to promote highly toxic substances, such as Carfentanil, without any restrictions. Among the identified markets, the legitimacy and reliability of both Agartha and Yakuza were questionable. While Agartha is considered a market offering scraped or fake listings in 90% of the cases (Darknetstats.com 2020, little information is available on the Yakuza market, which appears to be relatively recent with many sellers who are inactive, or have no recent transactions on their profiles.

On the other hand, Empire was found to be one of the largest marketplaces of interest on the darknet with more than 50.000 listings and weekly revenues of approximately 6,5 million USD (darknetstats.com; theonionweb.com). Although some of its Carfentanil vendors were inactive, or had a low 'trust' levels on the site, others had records of transactions ranging from 4 to a maximum of 1223. Some of them appeared to have well-established stores, suggesting they may offer a variety of other products.

Vendors

Overall 22 vendors selling Carfentanil were reported in the Yakuza (5), Agartha (9) and Empire (9), which were the only marketplaces listed as active at the time of the search. Further details on their activities are reported respectively in Tables 2, 3 and 4.

Table 2: Yakuza vendors

Seller	mytrade15	michaeldean	lifecrystal1	dcthug	Anonymsorter
No. of items	1	11	0	0	0
Spelling	carfentanil	carfentanil/ carfentanyl	-	-	-
Seller's Score	0	0	0	0	0
Username	mytrade15	michaeldean	lifecrystal1	dcthug	Anonymsorter
Account Created	06/12/2020	07/17/2020	06/23/2020	05/24/2020	06/10/2020
Last Login as midday 27/07/2020	7 hours ago	1 hour ago	2 weeks ago	2 weeks ago	3 days ago
Completed Transactions	0	0	0	1	0
PGP key	non-present	present	present	present	present
Items	prescription drugs, prepaid cards	drugs – prescription drugs, counterfeit money	no items	no items	no items
Ships From	United States	Anonymous	Anonymous	Anonymous	Anonymous
Other info		'We have been Trusted, Reliable and verified Vendor On Former Dream Market, Empire Market, Dream Alt Market, Agartha Market, Samsara Market and Nightmare Marketplace' VENDOR BANNED 04/08/2020 Last product posted 28/07/2020 Last activity: 31/07/2020			

Table 3: Empire vendors

Seller	johnjackmeths	Naturalremedy	Honeymoonia	chlnsaint	TheLittleGuys	JORDAN15	deaddrops	mackleslie	Missfentanyl
Score	0%	0%	100%	98.69%	97.64%	0%	85.71%	100%	100%
Vendor Level	1	1	1	7	5	1	1	1	2
Trust Level	1	1	1	7	5	1	1	1	1
Account Created	02/08/2020	10/06/2020	01/06/2020	##########	13/03/2019	18/07/2019	22/04/2019	##########	25/04/2020

Last Login as 05/08/2020	Today	04/08/2020	Today	Today	30/06/2020 (VACATION)	16/08/2019	Nov 26, 2019 (VACATION)	Today	Today
Sales	0	0	22	1223	495	0	27	4	32
PGP key	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Agartha vendors

Seller	**Asheleywilliams**	**GehLegit**	**biomed**	**baileythom**	**DrHeizen**	**cokydoc**	**VeronKushman**	**jakeflakes**	**Supplylord**
Score	99.153	98.1	99.552	99.238	91.1	97.108	100	90.333	80.571
Level	5	9	5	7	3	9	7	4	3
Account Created	10 months ago	10 months ago	15 months ago	13 months ago	12 months ago	13 months ago	7 months ago	11 months ago	8 months ago
Last Login as 05/08/2020	3 days ago	Today	Today	2 days ago	Today	2 days ago	today	Today	Today
PGP key	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes
Ships From		United Kingdom	United States	United States	Netherlands	United States	United States	Sweden	United States

The vast majority of vendors offered Pretty Good Privacy (PGP) ensuring encrypted communication with their clients. Although some of the vendors showed a high score and level of trust reported by users (which may be easy to manipulate), no information was available on their number of transactions completed. Vendors' contact details were commonly found in the description section of products. Contact methods included phone numbers, WICKR (an instant messaging app which allows the highest level of encryption, user privacy and verification) usernames and addresses, email addresses, social media handles and telegram; wallet/payment options were often available to facilitate the payment for these products using crypto currency, such as bitcoin and paysafe cards. Overall, WICKR was one of the most frequent handles utilised throughout all darknet platforms assessed: this is due to the high-level end-to-end encryption and to content-expiring messages, which allows greater privacy and lower traceability, thus allowing a safer trade of illicit goods. This highlights the importance and prevalence of private end-to-end encrypted messaging apps in the sale of Carfentanil online. It is also important to explore the validity of the contact methods provided, as vendors often provide stolen personal data as their own and utilise burner applications for communication.

Discussion and conclusion

Although the diffusion of NPS on the darknet has been increasingly reported (Broadhurst et al 2020; EMCDDA-EUROPOL 2019; UNODC 2019; Kruithof et al., 2016), to the best of our knowledge this is the first study with a focus on Carfentanil. The availability of such a dangerous drug among the sale lists of 63 vendors across 19 darknet marketplaces raises a number of unprecedented health and safety concerns in terms of both hazardous voluntary consumptions and potential use to harm others. Carfentanil is advertised here as part of a much wider repertoire of products, including other drugs, weapons, protected wildlife and human organs being sold by the same vendors. This confirms how the drug market is one of the major sources of income for organised crime and its association with other areas of criminality and terrorism. The flexibility in adding new activities and/or products to crime portfolios, also indicates that a new criminal business might become 'active' on demand only once a new profit opportunity emerges, despite vendors lacking specific expertise or experience in the handling, distribution or sale of these products. Although most of the marketplaces claimed to ban the advertising of highly potent drugs, the popularity of Carfentanil on such platforms increases the risk of unintentional dosing and contamination of products, which is life threating. While much emphasis has been given on the clinical implications posed by fentanyl and its derivatives, little attention has also been paid so far to their potential use as chemical weapons able to harm large populations or individuals. Furthermore, the exploitation of the postal system for the delivery of postal packages and parcels containing such illicit products deserves further careful consideration. In the case of Carfentanil, the risks of inadvertent contamination of postal and border force staff, who may examine suspicious parcels, remain high, especially in absence of guidance and regulations.

In a technologically-enabled society, the constant evolution and volatile nature of illicit drug markets allow vendors to rapidly counter law enforcement efforts, whilst avoiding existing regulations and drug control measures. Urgent action is required not only to provide more precise information to potential users, and professionals working with them, but also to influence the darknet market's internal regulations, which largely remains a grey and unexplored area. These considerations justify the importance of continued collaboration with law enforcement agencies and investment into novel scientific methods for the monitoring of the darknet in order to promptly identify future threats and safeguard the health and the security

of citizens as we did with this study. We believe our work addresses key governmental research priorities around serious and organised crime, while filling gaps in knowledge and informing policy in areas where "government does not yet have the extent or depth of data that it needs for an effective response" (National Audit Office, 2019: 10).

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