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How Legitimate Companies are Being Used for Sales for Illicit Online Products

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HOW LEGITIMATE COMPANIES ARE BEING USED FOR SALES FOR ILLICIT ONLINE PRODUCTS

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MASTER OF SCIENCE

ABSTRACT

The opioid epidemic began in the early 1990s due to the misuse and misinformation of pharmaceutical opioids. Since then, the increase in opioid use ranging from hydrocodone to fentanyl has become a world-wide issue. Over time, opioid use has evolved in many ways with three major waves of opioid use beginning with oxycodone, moving to heroin, and finally to fentanyl. Usage of online platforms and forums to sell and buy illicit opioids has increased significantly due to easier internet capabilities and social media platforms. A total of 1946 illicit online opioid sell sites were found in this study to show the ease of access to illicit sites on the Clearnet. Countless legitimate companies' services are being used on illicit opioid sell sites to buy and sell opioids through online methods. Bing, Bitcoin, Tawk(.)to, Gmail, and GoDaddy are legitimate companies being utilized on illicit opioid sell sites. If more legitimate companies were aware of improper use of service, less people would have access to illicit opioids.

Keywords: Fentanyl, Opioids, Social Media, Search Engines, Online Opioids Sell Sites

DEDICATION

I dedicate this paper to my family but most importantly my brother who constantly pressured me into going back to school to achieve something more for myself.

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INTRODUCTION

The opioid crisis has recently been growing exponentially. A report in 2017 by the National Center for Health Statistics showed the number of deaths in 2016 attributed to opioids was greater than 42,000, 27 % more than in 2015.[1] The United States accounts for 80% of the world's opioid consumption and approximately one third of adults in the US currently use prescription opioids.[2] In fact, more people use opioids than tobacco.[2] The opioid crisis has cost the US $442 billion a year including healthcare and law enforcement costs.[2] Opioids were responsible for 75 % of the overall overdose deaths in the years 1999-2014.[3] Between 1991 and 2013 opioids were increasingly prescribed to patients, totaling 4.3 million people using medically prescribed opioids in 2014.[3]

Opioids are categorized as narcotic analgesics in the Drug Recognition Expert Matrix and produce a slowed reaction time, euphoria, and respiratory depression with possible death, if taken in large quantities.[4] Opioid analgesics attach to the mu receptor in the brain, affecting the central nervous system (CNS) and are metabolized by the cytochrome P450 (CYP3A4) enzymes.[5] Because opioids are narcotic analgesics they are prescribed to treat pain.

One of the contributing factors leading to the opioid crisis was pain being identified as the fifth vital sign for patients in 1995.[3] Before the 1800s and even until 1914, chronic and acute pain was simply regarded as a sign of aging. Prior to the Harrison Narcotic Control Act of 1914, heroin and morphine were taken for a wide

variety of ailments, resulting in rampant addiction. Afterward, doctors began finding other ways to control pain, as opioids were limited to post-operative and terminal cancer patients.[8]

In 1986, the World Health Organization stated cancer pain was not being treated properly.[8] In the US, this led to hospitals receiving funding for positive patient surveys related to the patient's experiences while being treated for pain. Most hospitals found if pain was treated with opioid drugs, then patient surveys would reflect positively on the hospital resulting in more government funding opportunities.[8] Denial of pain medication led to lower patient satisfaction scores, resulting in reduced funding for the hospital and rapidly changed the way doctors managed pain.[2,3] Physicians felt pressured to manage pain, which led to the over prescribing of opioids, specifically.

Unintentionally, doctors and dentists as well as insurance companies were fueling the opioid crisis. Insurance companies reimbursed the cost of non-opioid medications in small amounts at a lower rate than opioids in bulk amounts making patients prefer opioids for pain management.[2] In the mid 2010's, 80% of users abusing opioids began with prescription opioids.[2]

The most prescribed opioid between 1997-2002 was OxyContin.[8] OxyContin, introduced by Purdue Pharma in 1996, is a high dose, extended release formulation of oxycodone. It very quickly became the most common opioid prescribed by doctors for chronic pain. OxyContin extended release allows the user to receive the active ingredient, oxycodone, in small amounts over the course of 12 hours. Unfortunately, users discovered that by crushing the pills into a powder and snorting, smoking, or injecting the contents, the user could get the full 12 hour potency within minutes, creating a quicker,

better high than other prescription opioids.[3] Ingesting a crushed OxyContin pill intranasally or intravenously results in a very rapid adsorption into the body allowing the opioid to affect the central nervous system faster than other routes of administration.[6]

Purdue Pharma was involved in deceptive advertising of OxyContin. Purdue misled physicians and patients by downplaying the addiction qualities of OxyContin.[8] Purdue was eventually sued for falsification of data, resulting in a $634.5 million fine to the Justice Department as well as another $19.5 million to 26 states and the District of Columbia.[8]

Once the addiction rate for OxyContin had been established, Purdue Pharma patented a new abuse deterrent formulation (ADF) of OxyContin to lessen its appeal to drug users. The ADF included an anti-crush formulation and if the pill was dropped into water, it would turn into a gel that could not be injected.[3] A study by Evans et al. showed that the anti-crush formulation of OxyContin proved difficult for users to inject or snort. If the pill cannot be effectively crushed into a powder, it cannot be rapidly absorbed.[6] This led to a lower addiction rate for the reformulated ADF OxyContin compared to the original OxyContin.[6] Once Purdue changed the formula for OxyContin, illicit users had to find other ways of obtaining the desired euphoric feeling.[8] Many users turned to heroin to satisfy their addiction.[3]

The study by Evans et al. found a quantitative correlation between reformulation of OxyContin and the increase of heroin overdose death.[3] The ADFs added into the OxyContin prevented users from abusing oxycodone, leading addicts to use other street drugs, such as heroin. The study explains that the use of ADFs within opioids did reduce

the prescription drug mortality rate, however, the FDA stated that there was not enough data to support the fact that ADFs help deter the addiction rate of opioids.[3]

Of previous prescription drugs abusers, 70 % of users claim heroin was their next drug of choice.[3] Heroin has been widely used for generations throughout the world. The production of heroin is divided into two main regions, using Mississippi as a dividing point. The regions east of Mississippi are primarily white powder heroin regions and west of Mississippi are primarily black tar heroin regions.[3] Most of the heroin in the United States comes from Mexico.[3] According to the DEA, 79 % of the heroin seized from users comes from Mexico.[3] Over time, the price of heroin from Mexico has decreased. In 1981, one gram of heroin cost $3,000, in 2012 the cost of one gram of heroin had decreased to $500.[3]

Data from the National Survey on Drug Use and Health (NSDUH) from 2002 to 2013 indicated that deaths from heroin overdoses had a correlation to past prescription opioid use.[7] The most significant finding was the demographic of users with the greatest percentage of heroin overdose deaths were young, lower income males.[7] Lower income areas are known for lack of health insurance and lack of health care or Medicaid. The heroin overdose demographics also saw the percentage of women involved in heroin overdoses increase over time. Between 2011-2013, there was a 35.7 % increase in heroin overdose deaths which attributed overall to the epidemic status of opioid use in America.[7]

In 2013, NSDUH data showed a 150 % increase in heroin use between 2007 and 2013 as drug use became less specific to age, race, and location in the U.S.[7] An important question is whether the user became addicted through medical or nonmedical opioid use. There is a likely trend between the number of opioids prescribed to the number of heroin

users and overdoses seen in an area. The more opioids prescribed, the more heroin use and deaths seen in the region.[7]

The study by Jones et al. showed in many cases when the cause of death was a heroin overdose, very often another drug was present, whether that be cocaine, marijuana, or alcohol. The study calls this "poly-substance" use and can be seen in cases throughout the epidemic.[7] Cocaine and heroin use together is more prevalent in overdose death cases.[7] The study also found that during this period, there was a greater availability of heroin. For instance, heroin was being made, processed, and transported faster than prior years. In many different instances, purity of the heroin was higher, making it more potent and addictive as well as dangerous to the user. The greater availability at a lower cost made the movement of heroin throughout communities easier.[7]

In 2015, fentanyl overdoses began to significantly increase as seen in previous trends with prescription opioids and heroin. More opioid users were dying from fentanyl than heroin or prescription drugs.[8] After October 16, 2017, the opioid crisis was officially declared an epidemic by the US government due to the increase of opioid overdoses, including the rise in fentanyl use.[8] Fentanyl overdoses were first seen in 1972 by professionals in the medical field misusing the drug for their own use.[5]

Fentanyl was first synthesized by Dr. Paul Janssen in Belgium 1960.[5] Dr. Janssen wanted to find a more potent and rapid-acting analgesic to help aid in the fight against chronic pain. Using morphine and meperidine as models, Janssen studied their molecular structure to determine which drug would be easier to manipulate.[5] The molecular structure of meperidine was less complex. Janssen and his researchers were aiming for a more fat soluble molecule and attempted to add benzene rings, methyl groups, and

nitrogen to meperidine.[5] The newly synthesized drug also needed to be able to bind to the mu receptor in order to provide the same euphoric and pain relieving effects in the patient.[5] The first attempt produced the drug phenoperidine.[5] They synthesized the first molecules of fentanyl in 1960. Fentanyl was 10 times more potent than phenoperidine and 100-200 times more potent than morphine in early trials.[5] When fentanyl was first introduced to the medical community, it was only used as an intravenous analgesic.[5] Fentanyl was first used in the US as an intravenous pain reliever in hospitals in 1963. The drug was not widely used for clinical pain relief in the U.S. until 1968.[5]

Fentanyl can be up to 100 times more potent than morphine and has a quick concentration peak (Cmax) and short duration.[1] The best clinical use for fentanyl came with the introduction of the fentanyl transdermal patch or Sublimaze. The patch was used to treat chronic pain in terminal cancer patients. Another form of fentanyl administration for chronic pain is fentanyl lollipops or lozenges (Actiq). The transmucosal form of ingestion helps aid chronic pain by slowly administering the drug as the user slowly ingests the drug by licking or sucking the lollipop or lozenge.[5] Within the last 20 years, fentanyl has also been widely used as a form of anesthesia for patients undergoing surgery.[5]

Recently, fentanyl analogs have been surfacing for illicit uses. The pharmacology of Fentanyl and its analogs, such as sufentanil, alfentanil, remifentanil, and Carfentanil have similar effects, however the potency varies between analogs.[5] The route of administration correlates to the onset of the opioid effect. For instance, intravenous administration of fentanyl takes effect within 1 to 2 minutes.[5] The Cmax for fentanyl is between 8 to 16 hours after transdermal administration.[5] Because fentanyl is so potent,

analgesic effects occur with low doses. The duration of the effects can last up to 4 hours if injected or taken by trans mucosal methods.[5] Transdermal administration varies because it is administered over time, so the half-life of fentanyl through transdermal administration is up to 17 hours.[5] Respiratory depression is only seen at higher doses, but it still poses a threat with medical use as well as illicit use.[5]

Early research into synthetic opioids focused on obtaining a higher potency at a smaller dose. However, synthetic opioids are now added to enhance the effect of street drugs. In 2013, a higher quantity fentanyl was illicitly manufactured than the quantity produced for medical prescriptions.[9] Illicitly manufactured fentanyl is rising in popularity with drug users, not only in the United States, but also in areas such as Europe and Asia as well as Australia.[9] Fentanyl has also made an appearance in counterfeit oxycodone and hydrocodone pills as well as benzodiazepines.[9] Because illicit pills carry the same identifying marks as the legitimate pills, most people, even users, struggle to decipher which pills are illicitly made and which ones are credible pills.[9] Fentanyl is being identified in almost any illicitly manufactured drug, such as amphetamines and cocaine, due to its cheap cost.[9]

In a study done by Mars et al., the emergence of fentanyl in street drugs began to influence the relationship between dealer and user.[9] Users claimed that they could differentiate between the drugs when using heroin laced with fentanyl. The illicit drug community began warning each other of dealers that would sell products adulterated with fentanyl or use adulterated fentanyl products as an advertisement as a better high for less cost.[9]

Naloxone is a competitive antagonist for opioids at the opioid mu receptor in the brain. In theory, naloxone reverses the effects of an overdose and lessens the dangerous side effects of the opioid. Naloxone has been used since 1971 as a competitive antagonist to treat opioid overdoses.[1] Naloxone was administered through intravenous, intramuscular, and subcutaneous methods when first introduced in the 1970s, after FDA approval. Since 2014, the most common administration methods are intranasally and subcutaneously because of the rapid absorption and metabolism to counteract an opioid overdose.[1] Evizo and Narcan Nasal Spray are the most common brands of subcutaneous and intranasal naloxone drugs being used in the US.

In response to the opioid pandemic, most medical centers carry naloxone and buprenorphine to help counteract any opioid overdose that may occur within the medical facility.[8] However, the introduction of the naloxone "antidote" has not curbed the opioid overdose death rate. The main reason may be the cost. Both brands can range from $100-$3800, making it unavailable to the greatest demographic of users, young males. Synthetic opioids also pose a large problem for treatment with naloxone as an overdose treatment. If the person administering the naloxone is not properly trained, there could be adverse effects that were not anticipated. For instance, because synthetic opioids are generally more potent and powerful, one dose of naloxone may not suffice to successfully treat the overdose.[1] More than one dose of naloxone may be needed to stabilize the patient's vital signs. Carfentanil is one of the most potent synthetic opioids and may require almost 18 mg of naloxone to reverse the effects of the opioid compared less than 0.4 mg for a typical opioid overdose.[1] The FDA suggests starting at the low dose of 0.4-2.0 mg of naloxone and continuing to readminister a dose as the patient needs. For a

heroin overdose, the low-end dosage is generally effective, while fentanyl and fentanyl analogs may require either a higher initial dose or continual administration of naloxone.

Because fentanyl is cheaper to produce than heroin, there has been an increase in cutting heroin with fentanyl. Illicit heroin producers were also struggling to produce enough product for demand. Manufacturers added fentanyl without taking its potency into account. Consequently, there was a rise in the number of overdoses by users who were unaware of the fentanyl in the drug.[9] Currently, there are fentanyl test strips accurate enough to detect the presence of fentanyl in a drug sample.[9] Users can detect fentanyl mixed in with their "normal" daily drugs.

The growth of social media has contributed to the current opioid crisis.[10] Cryptomarkets and online drug venders have provided users with a better way to shop for their drugs. Users can compare pricing and shipping methods before buying any drugs.[9] While the Darknet is generally seen as the source for most illicit online drug sales, in fact many law enforcement agencies have found and prosecuted cases that used the Clearnet to sell opioids online.[14]

Twitter currently has 316 million active users and approximately one third of adolescents use Twitter.[10] The use of Twitter to engage in illicit behavior is common for the adolescent age group. The term "Oxy", slang for OxyContin/Oxycodone, is the fifth most commonly used drug term on Twitter.[10] Researching social media can be used to gain knowledge on how drug information is spread throughout the US and the world.[10] Collecting data on illicit drug use through social media can provide information to such agencies as the World Health Organization, the FDA, and law enforcement for

developing policies to slow the spread of drug use on social media platforms and the internet.[10]

The widespread use of social media has led to an increase in use of Direct-to-Consumer advertising (DTCA) in relation to online drug sales.[11] Most developed countries have outlawed DTCA in hopes of deterring any online illicit sales. The United States does not have any laws regulating DTCA opening the US internet to online drug sales. The main threat to public health regarding DTCA is the misleading legality of the sites and the quality of the substances sold online.[11] A study completed by Mackey et al. describes the use of a false DTCA on various social media sites showing the United States had the most visits to the DTCA on each social media platform.[11]

There are three types of drug markets that can be identified by the type of purchases: the street market, where drugs are purchased on the street from gangs and dealers, the free market, where party drugs like marijuana and ecstasy are purchased through small friend groups, and e-commerce market, where drugs are sold online.[12]

In 2008, the Ryan Haight Online Pharmacy Consumer Protection Act (RHA; HR6353) was passed and helped the law respond to any illicit sale of controlled substances being directly sold to consumers online.[13] Even with the RHA being passed in 2008, the number of illicit opioids and non-medical prescriptions use has increased partly due to the increase in internet traffic. For instance 84% of American adults use the internet and 65% use social media.[13] In fact, the nonmedical use of opioids has quadrupled since 1999 according to the Center for Disease Control.[13]

In June 2018, a summit with the FDA, the DEA, Twitter, Facebook, Alibaba, Pinterest, and other government agencies held a summit to exchange ideas in the fight against the opioid crisis online.[14] Many social media platforms claimed that there is simply too much information on each platform to search and block all illicit advertisements and illicit behaviors. However, the use of a social media platform or search engine network to sell illicit opioids often breaks the terms and conditions of the contract, giving the company the right to remove any information permanently.[14] Many social media companies such as Facebook have implemented a program redirecting the user to educational pages about opioid addiction when certain keywords are searched on their platform.[14] Pinterest has blocked certain keywords and Google gives warning letters from the FDA at the top of results pages regarding opioids.[14]

Google was fined $500 million for allowing ads on their website that advertised illegal and illicit drug material.[18] Google, Bing Yahoo, and Pinterest were warned in February 2018 of how their platforms were being used for illicit drug selling online pharmacies.[18] Just by searching Twitter alone, keywords such as codeine, fentanyl, hydrocodone, oxycodone, Percocet, and Vicodin can give results of over 200,000 tweets combined.[18] By adding other keywords like “buy” “sell” “online” to drug keywords enlists thousands more results indicating the ease of finding drugs on Twitter alone.[18]

Illicit sellers are using legitimate sites like eBay and Craigslist as well as social media to post advertisements for prescription and illicit opioids.[15] These online markets also use cryptocurrencies, such as Bitcoin because of the easy use, privacy, and lack of traceability for sellers and purchasers. Hundreds of millions of dollars are estimated to be used annually for drug sales through cryptomarkets.[15] Before 2014, prescription drug

sales through cryptomarkets were only seen 10% of the time.[15] The prominent issue with online cryptomarkets is these markets also sell more detrimental drugs than just prescription opioids. For instance, a search on hydrocodone might lead a consumer to a specific online market, but may induce them to switch to heroin and fentanyl due to the ease of purchase and price.[15]

There are additional hazards to purchasing drugs online. Other online drug sites will accept payment, but never actually ship the product.[16] If the drug is even received, it may not contain the drug or the drug may be adulterated.[16] One study from Rhumorbabe et al. shows that cocaine purchased from a darknet site proved to have not only cocaine but palmitic acid, glucose, levamisole, inositol, and stearic acid.[16] In other words, consumers are unaware of the actual chemical composition of the product and the dangers of what unknown chemicals can do to a person. In other cases, credit card or personal information will be stolen and used by the seller.

All 50 states have prescription drug programs such as Medicaid programs that cover buprenorphine to treat opioid abuse disorder, and naloxone access.[17] Syringe services programs (SSP) have been in effect since the 1980s, when an increase in opioid abuse led to an increase in syringe related diseases, such as HIV and Hepatitis.[17] SSPs allow users to exchange used syringes for unused syringes. There are differing opinions on SSPs as some see the program as enabling users while others view SSPSs as reducing money required for HIV and other syringe related diseases by lowering the number of people affected by deadly blood borne pathogens.[17]

One of the main responses to the opioid epidemic by states was guidelines for the proper prescribing of opioids by medical professionals attempting to treat pain. Opioids

are more efficient in treating pain and tend to be prescribed more often than non-opioid pain management medications for terminal and chronic pain.[17] States also have begun limiting the number of doses in a prescription, for instance, the CDC recommends for patients with acute short term pain receive less than a seven day supply of an opioid.[17] There is also some backlash from medical professionals complaining that a less than seven day supply cannot actively treat patients with chronic pain such as terminal cancer patients, which can cause an inconvenience to patients who routinely take opioids for chronic pain.[17]

Drug monitoring programs have been put in place to ensure that patients cannot see multiple doctors to receive multiple prescriptions. The issue with these programs is that medical facilities must actively use the programs. Many do not, citing the programs are not efficient and time consuming.[17] Education has been a large part of the response to the opioid pandemic, not only for the public, but also the prescribers. Only eight states require education for professionals who are DEA registered to prescribe controlled substances.[17]

Take back programs are helpful but not widely utilized. Only 0.3% of all drugs prescribed are returned via take back programs in Kentucky.[17] Treatment programs, whether non-medicated rehab or medicated methadone clinics, are potential solutions to the pandemic because they rely heavily on treating the addiction. In many studies, medicated treatments such as methadone and buprenorphine are found to be more effective in the long-term than non-medicated programs. Funding for these programs is scarce and most rehab and treatment facilities are privately owned.[17]

The widespread use of Narcan has grown in acceptance over the recent years because many states have decriminalized it.[18] The disadvantages of naloxone are the price and miseducation creating a false sense of security amongst opioid users. Users may feel a false sense of security due to the knowledge of having an "antidote" to save the user if an overdose were to occur.

In addition, 40 states have Good Samaritan laws protecting anyone calling 911 in reference to a drug overdose from persecution.[17] Unfortunately, 10 states still do not have the Good Samaritan law in effect.

Another possible solution is to bring attention to legitimate companies that are used illicitly online for the sales of opioids, which is the objective in this study. The focus is to disrupt the process, as what the consumers cannot buy cannot kill them.

MATERIALS

Dell Intel core i5 8th Generation laptop computer with internet capabilities, virtual private network (VPN), and virtual machine (Oracle VM virtual box). Programs such as Microsoft office with Word, Excel, and PowerPoint. Gmail with Google doc access, Facebook, Twitter, Instagram, and Proton Mail accounts were created for incognito searching. Google Chrome Extensions including Highlight This, and image searches were also used. Access to IP Info DNS query to determine registrar information for each website found.

METHODS

Opioids Keyword Searches

All data was collected beginning July 13, 2020 to January 19, 2021. A keyword list was generated, including chemical names, common drug, and slang terms. Opioid names were divided into categories of non-narcotic analgesics and narcotic analgesics seen in Appendix A. The narcotic analgesics were further sub categorized into categories such as heroin, morphine, oxycodone, hydrocodone, and thebaine. Transactional keywords such as buy, sell, use, bitcoin, online, and overnight were added to keyword list and searched with Google, Duckduckgo, Bing, Yahoo, and Millionshort.

Highlight This

The Highlight This extension, available through Google, enables users to manually enter keywords that will then be highlighted on any web page. The Highlight This extension allows users to save and download lists to be shared with other users. It also supports color coding groups of terms.

Search Method

An analyst, when beginning a search for illicit domains, would use an opioid keyword such as fentanyl. The analyst would add a transactional keyword such as “buy”, “sell”, “online”, “overnight shipping” to the keyword in a search bar on a search engine. For instance, the term “buy fentanyl” was searched starting with one search method such as Bing. All illicit domains that resulted in that search would be recorded in the opioids master sheet. Once one keyword term exhausted of the search method, the same keyword term was searched on another search method such as Google. This process was repeated for all search engines and methods before searching another search term in the same

manner. Phone numbers and email addresses were also searched in Google to obtain any illicit domains connected through contact information.

Opioid Image Searches

Images searches were used in addition to standard search engines and social media searches to discover any image of illicit drugs that could result in multiple domains using the same image. Keywords pairs were entered to generate a list of images. Images associated with the sale of illicit opioids were then searched by right clicking on the image and selecting "Search Google for Image" if doing a Google search. Any resulting illicit domains were collected the same as for the keyword searches.

Social Media Searches

The opioid keywords and transactional keywords were used on social media platforms Facebook, Twitter, and Instagram, Pinterest, YouTube, and LinkedIn. Pages, posts, and groups URLs were recorded along with the handle, entity ID, any domains listed, likes, and follows of any social media ties indicating the sale of illicit opioids online through social media platforms. Searching methods on Twitter also involved the use of opioid keywords with a hashtag to receive resulting illicit domains. Domains listed on the Master Sheet were searched directly on social media platform search bars to identify any social media ties utilized by the same domains.

Domain Decision Criteria

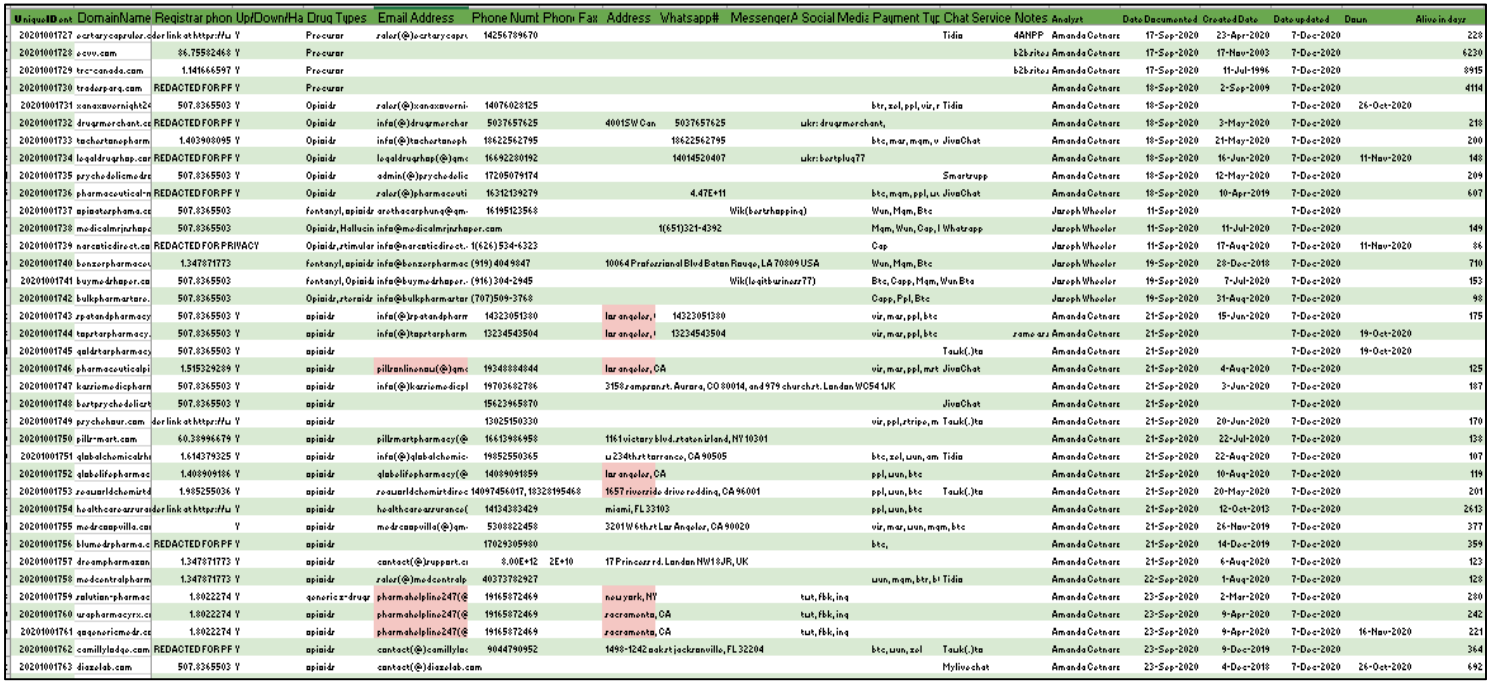
The legitimacy of every domain found was compared against a set criterion. Any domain that claimed no prescription was needed for purchase of prescription medications or controlled substances was flagged as an illicit online domain and recorded for future

analysis. Another method of determining legitimacy of online domains relied on the webpage itself. Any domains that used unprofessional terminology with grammatical errors were investigated further for legitimacy. Domains that used advertising terms such as “buy fentanyl here” or had lists of opioid names on their webpage does so to show up more often in search results on major search engines. These domains would type paragraphs of terms on their page for this purpose. Another key method of determining the legitimacy of a domain rested in the search method. For instance, when searching on Bing, text boxes would appear above a result stating that domain was unsafe, and the user should be aware of the dangers of buying drugs online. Essentially, any domain that operated in violation of any American law was listed as an illicit online domain. Because this study focused on illicit opioid sell sites, laws pertaining to the buying and selling of opioids were used to determine the legitimacy of the found domains.

Opioids Master Sheet

Data for illicit opioids selling sites were added into the Opioids Master sheet including: a unique identifier, domain name, search method, IP address, regional registry, country code, registrar/host, registrar location, registrar phone number, registrar email address, is the domain up, down, hacked, category of drugs sold, fax number, phone number, address, email address, messenger apps, WhatsApp number, social media, payment methods, chat services, analyst that found the domain, date found, is the domain active, status of domain, and day the domain was created.

RESULTS AND DISCUSSION



UniqueID ont	DomainName	Registrar phon	Up/Down/Ha	Drug Types	Email Address	Phone Numt	Phon	Fax	Address	Whatsapp#	Messenger	Social Media	Payment Typ	Chat Service	Notes	Analyst	Date Documented	Created Date	Date updated	Down	Alive in days
20201001727	ecartarycapralor.cdo	rlink at https://hu	Y	Precursor	zalor(@)ecartarycapra	14256789670								Tidia	4ANPP	Amanda Cotnare	17-Sep-2020	23-Apr-2020	7-Dec-2020		228
20201001728	ecuv.com	86.75582468	Y	Precursor											b2brites	Amanda Cotnare	17-Sep-2020	17-May-2003	7-Dec-2020		6220
20201001729	trc-canada.com	1.141666597	Y	Precursor											b2brites	Amanda Cotnare	17-Sep-2020	11-Jul-1996	7-Dec-2020		8915
20201001730	traderpro.com	REDACTED FOR PF	Y	Precursor												Amanda Cotnare	18-Sep-2020	2-Sep-2009	7-Dec-2020		4114
20201001731	xanaxovernight24	507.8365503	Y	Opioids	zalor(@)xanaxovernig	14076028125							btr, zel, ppl, vir, r	Tidia		Amanda Cotnare	18-Sep-2020		7-Dec-2020	26-Oct-2020	
20201001732	drugmerchant.co	REDACTED FOR PF	Y	Opioids	infa(@)drugmerchar	5037657625			4001SW Can	5037657625		ukr: drugmerchant,				Amanda Cotnare	18-Sep-2020	3-May-2020	7-Dec-2020		218
20201001733	tachortanopharm	1.403908095	Y	Opioids	infa(@)tachortanoph	18622562795				18622562795			btc, mar, mqm, v	JivaChat		Amanda Cotnare	18-Sep-2020	21-May-2020	7-Dec-2020		200
20201001734	legaldrugshop.com	REDACTED FOR PF	Y	Opioids	legaldrugshop(@)qmc	16692280192				14014520407		ukr: beatplug77				Amanda Cotnare	18-Sep-2020	16-Jun-2020	7-Dec-2020	11-Nov-2020	148
20201001735	pzychedelicmedz	507.8365503	Y	Opioids	admin(@)pzychedelic	17205079174								Smartrupp		Amanda Cotnare	18-Sep-2020	12-May-2020	7-Dec-2020		209
20201001736	pharmaceutical-n	REDACTED FOR PF	Y	Opioids	zalor(@)pharmaceuti	16312139279				4.47E+11			btc, mqm, ppl, ux	JivaChat		Amanda Cotnare	18-Sep-2020	10-Apr-2019	7-Dec-2020		607
20201001737	apinatorpharma.co	507.8365503		fentanyl, opioids	orethacarphung@qm	16195123568					Wik(beatthapping)		Wun, Mqm, Btc			Amanda Cotnare	11-Sep-2020		7-Dec-2020		
20201001738	medicalmrjnrhap	507.8365503		Opioids, Hallucin	infa@medicalmrjnrhaper.com					1(651)321-4392			Mqm, Wun, Cap, I	Whatsapp		Amanda Cotnare	11-Sep-2020	11-Jul-2020	7-Dec-2020		149
20201001739	narcaticdirect.co	REDACTED FOR PRIVACY		Opioids, stimulan	infa@narcaticdirect.	1(626) 534-6323							Cap			Amanda Cotnare	11-Sep-2020	17-Aug-2020	7-Dec-2020	11-Nov-2020	86
20201001740	benzorpharmaco	1.347871773		fentanyl, opioids	infa@benzorpharmac	(919) 4048847			10064 Prafozzi anal Blvd Baton Rauge, LA 70809 USA				Wun, Mqm, Btc			Amanda Cotnare	19-Sep-2020	28-Dec-2018	7-Dec-2020		710
20201001741	buymedshaper.co	507.8365503		fentanyl, Opioids	infa@buymedshaper.	(916) 304-2945					Wik(legitburnerz77)		Btc, Capp, Mqm, Wun	Bta		Amanda Cotnare	19-Sep-2020	7-Jul-2020	7-Dec-2020		153
20201001742	bulkpharmartaro.	507.8365503		Opioids, steroids	infa@bulkpharmartar	(707)509-3768							Capp, Fpl, Btc			Amanda Cotnare	19-Sep-2020	31-Aug-2020	7-Dec-2020		98
20201001743	xpstandpharmacy	507.8365503	Y	opioids	infa(@)xpstandpharm	14323051380			lar angelor, (	14323051380			vir, mar, ppl, btc			Amanda Cotnare	21-Sep-2020	15-Jun-2020	7-Dec-2020		175
20201001744	tapxtarpharmacy.	507.8365503	Y	opioids	infa(@)tapxtarpharm	13234543504			lar angelor, (	13234543504			vir, mar, ppl, btc		same as a	Amanda Cotnare	21-Sep-2020		7-Dec-2020	19-Oct-2020	
20201001745	qaldxtarpharmacy	507.8365503	Y	opioids										Tauk(.)tta		Amanda Cotnare	21-Sep-2020		7-Dec-2020	19-Oct-2020	
20201001746	pharmaceuticalpi	1.515329289	Y	opioids	pillranlinenau(@)qmc	19248884044			lar angelor, CA				vir, mar, ppl, mxt	JivaChat		Amanda Cotnare	21-Sep-2020	4-Aug-2020	7-Dec-2020		125
20201001747	kazziemedicpharm	507.8365503	Y	opioids	infa(@)kazziemedicpl	19703682786			3158 sampran rt. Aurora, CO 80014, and 979 church rt. Landan WC54 1JK							Amanda Cotnare	21-Sep-2020	3-Jun-2020	7-Dec-2020		187
20201001748	beatpsychedelicst	507.8365503	Y	opioids		15623965870								JivaChat		Amanda Cotnare	21-Sep-2020		7-Dec-2020		
20201001749	pzychehaur.com	der link at https://hu	Y	opioids		13025150330							vir, ppl, stripe, m	Tauk(.)tta		Amanda Cotnare	21-Sep-2020	20-Jun-2020	7-Dec-2020		170
20201001750	pills-mart.com	60.38996679	Y	opioids	pillsmartpharmacy(@	16613986958			1161 victary blvd. staten island, NY 10301							Amanda Cotnare	21-Sep-2020	22-Jul-2020	7-Dec-2020		138
20201001751	qlabalchemicalrh	1.614379325	Y	opioids	infa(@)qlabalchemic	19852550365			u 234th rt tarrance, CA 90505				btc, zel, uun, am	Tidia		Amanda Cotnare	21-Sep-2020	22-Aug-2020	7-Dec-2020		107
20201001752	qlabolifepharmac	1.408909186	Y	opioids	qlabolifepharmacy(@	14089091859			lar angelor, CA				ppl, uun, btc			Amanda Cotnare	21-Sep-2020	10-Aug-2020	7-Dec-2020		119
20201001753	zeauarldchemirtd	1.985255036	Y	opioids	zeauarldchemirtdirec	14097456017, 18328195468			1657 riverzide drive redding, CA 96001				ppl, uun, btc	Tauk(.)tta		Amanda Cotnare	21-Sep-2020	20-May-2020	7-Dec-2020		201
20201001754	healthcare-azrurad	der link at https://hu	Y	opioids	healthcare-azrurance(	14134383429			miami, FL 33103				ppl, uun, btc			Amanda Cotnare	21-Sep-2020	12-Oct-2013	7-Dec-2020		2613
20201001755	medrcanpvilla.com	Y		opioids	medrcanpvilla(@)qm	5308822458			3201 W 6th rt Lar Angelor, CA 90020				vir, mar, uun, mqm, btc			Amanda Cotnare	21-Sep-2020	26-Nov-2019	7-Dec-2020		377
20201001756	blumedrpharma.c	REDACTED FOR PF	Y	opioids		17029305980							btc,			Amanda Cotnare	21-Sep-2020	14-Dec-2019	7-Dec-2020		359
20201001757	dreampharmazan	1.347871773	Y	opioids	contact(@)ruppart.cl	8.00E+12	2E+10		17 Princess rd. Landan NW1 8JR, UK							Amanda Cotnare	21-Sep-2020	6-Aug-2020	7-Dec-2020		123
20201001758	medcentralpharm	1.347871773	Y	opioids	zalor(@)medcentralp	40373782927							uun, mqm, btr, bt	Tidia		Amanda Cotnare	22-Sep-2020	1-Aug-2020	7-Dec-2020		128
20201001759	zalution-pharmac	1.8022274	Y	opioids	qeneric x-druqs	pharmahelpline247(@	19165872469			new york, NY		tut, fbk, inq				Amanda Cotnare	23-Sep-2020	2-Mar-2020	7-Dec-2020		280
20201001760	wrapharmacyrx.co	1.8022274	Y	opioids	pharmahelpline247(@	19165872469			zacramenta, CA			tut, fbk, inq				Amanda Cotnare	23-Sep-2020	9-Apr-2020	7-Dec-2020		242
20201001761	qaqenericmedr.co	1.8022274	Y	opioids	pharmahelpline247(@	19165872469			zacramenta, CA			tut, fbk, inq				Amanda Cotnare	23-Sep-2020	9-Apr-2020	7-Dec-2020	16-Nov-2020	221
20201001762	camillyladqo.com	REDACTED FOR PF	Y	opioids	contact(@)camillylac	9044790952			1498-1242 soakrt jacksranville, FL 32204				btc, uun, zel	Tauk(.)tta		Amanda Cotnare	23-Sep-2020	9-Dec-2019	7-Dec-2020		364
20201001763	diazolab.com	507.8365503	Y	opioids	contact(@)diazolab.com									Mylive chat		Amanda Cotnare	23-Sep-2020	4-Dec-2018	7-Dec-2020	26-Oct-2020	692

Figure 1. An Example of the Master Sheet Information

Master Sheet Data Collection

All domain information from searching online was recorded in an excel document (Figure 1). The data includes the domain, registrar, contact information including, telephone numbers, emails, social media links, payment methods, addresses, chat services, and messenger app services. Any duplicates were highlighted in red. Duplicates highlighted in red could be email addresses used on two different domains indicating a connection between two different domains. Highlighted duplicates helped ensure domains were not listed more than once.

The Statistical Analysis

The data such as the search method, social media ties, Regional Internet Registry, Registrar, Registrar longevity, Registrar location, chat services, payment methods, and email domains were collected from the Master sheet and into a separate Excel file and several Excel functions were used to tabulate the data before analysis. The COUNTIF function was used to track the total number of drug sell sites, offline sites, and Regional Internet Registry (RIR) on weekly basis to determine any trends.

Keywords List and Slang

Drug terms were categorized according to the Drug Recognition Expert (DRE) matrix (Table 1). Categories include Central Nervous System (CNS) depressants, CNS stimulants, hallucinogens, dissociative anesthetics, narcotic analgesics, inhalants, and cannabinoids. Additional categories were added such as research chemicals, compounds, Kratom, Human Growth Hormones, antibiotics, and steroids. Each category was further divided into subcategories. For instance, narcotic analgesics can be separated into opioids

and non-opioid analgesics. The drug name, brand names, generic names, street terms, formulas, CAS numbers and analogs, an example showing part of the opioids category is shown in Table 1. Including all categories of drugs aided the researchers to identify illicit drug sites and then narrow the focus to opioids.

Common terms associated with each drug were recorded in Table 2 where analysts could search for multiple terms per drug. The first column is the class of drug listed by the DRE matrix, the second column is the category of drug and the third column has any associated terms.

Table 1. Categorized Opioid Keywords

Narcotic Analgesics		
Opioids	Heroin	(Dual) Acetylated Morphine or C21H23NO5
		Heroin Hydrochloride (1502-95-0) (561-27-3) C21H23NO5 HCL
		Diacetylmorphine (17-methyl-7,8-didehydro-4,5alpha-epoxymorphinan-3,6alpha-diyl diacetate)
		Diacetylmorphine (Diamorfina,Spanish) (EINECS 209-217-7) (Morphine Diacetate)
		7,8-Dihydro-4,5-alpha-epoxy-17-methylmorphinan-3,6-alpha-diol diacetate
		Acetomorphine
		//
		Black Tar, Brown Heroin ((5α,6α)-7,8-didehydro-4,5-epoxy-17-methylmorphinan-3,6-diol diacetate)
		CAS-561-27-3
		Morphinan-3,6-alpha-diol, 7,8-didehydro-4,5-alpha-epoxy-17-methyl-, diacetate (ester)
		Morphinan-3,6-diol, 7,8-didehydro-4,5-epoxy-17-methyl- (5alpha,6alpha)-, diacetate (ester)
	Thebaine	C19H21NO3
	Morphine	Kadian, MS Contin, Mscotin,
		Oramorph C17H19NO3
		Etorphine, Etrophine Hydrochloride or C25H33NO4

Table 2. Common Keywords per Drug

Common Keywords	Drug Type
AM-2201	Fentanyl
AM-2233	Fentanyl
Furanyl	Fentanyl
u-47700	Fentanyl
u-49900	Fentanyl
u-48800	Fentanyl
Duragesic	Fentanyl
Subsys	Fentanyl
abstral	Fentanyl
wildnil	Fentanyl
thienyl	Fentanyl
thiofent	Fentanyl
actiq	Fentanyl
sublimaze	Fentanyl
dimethylfentanyl	Fentanyl
difluorofentanyl	Fentanyl
allylfentanyl	Fentanyl
fu-f	Fentanyl
methylbutyrfentanyl	Fentanyl
//	//
phenylpropanoylfentanyl	Fentanyl
fluorobutyrfentanyl	Fentanyl
para-fluorofentanyl	Fentanyl
p-f-fu-f	Fentanyl

The third sheet is Opioid Slang Keywords as shown in Table 3 which lists common illicitly sold drugs with various street names commonly used online. Slang terms are useful, specifically with online forums and social media. The first column shows the drug name and the adjacent columns contain the various street names commonly used in informal settings. Slang terms are used when searching social media

and forums to determine if opioids were in any conversations or posts on social media platforms.

Table 3. Opioid Slang Keywords

Fentanyl	Fenty	China Town	China Girl	Tango and Cash	Murder Eight	King Ivory	friends
	Goodfellas	Dance Fever	Great Bear	Apache			
Heroin	Black Tar	White Horse	White Pony	China White	Dope	Black Suff	Brown Sugar
	Golden Girls	Antifreeze	Big H	Blow Dope			
Codeine	Cody	the syrup	schoolboy	purple drank	the slurr	fours	doors
	lean	loads					
Vicodin	Vikes	hydros	vikos	tabs	watsons	lorries	357s
	vickies						
OxyContin	The Ox	OC	Oxy	Kickers	hillbilly heroin	blues	the 80s
	the 40s						
Opana	Pink O	the O bomb	Mrs O	pink lady	pink heaven	blues	blue heaven
	oranges	stop signs	octagons				

Highlight This

After opioid keywords were added to the Highlight This extension, every keyword was highlighted in the search results page. The extension would highlight keywords of interest previously determined and would help determine if any online domain was selling any illicit material visually drawing attention to the highlighted terms. All keywords listed in Appendix A were added into the Highlight This extension.

Total Number of Sites

Table 4 shows the total number of illicit opioid selling sites identified between July 13, 2021 and January 19, 2021. A total of 1,946 domains offering opioids and of these sites, 1,460 were still online as of January 19, 2021. Beginning the study at 1,139, the study grew overtime to finish with 1,946 domains.

Table 4. Total Number of Domains per Month

Month	July	August	September	October	November	December	January
Total Domains	1139	1467	1758	1843	1915	1940	1946

Search Methods

As shown in Table 5, most of the sites selling illicit opioids were found using the Bing search engine, accounting for nearly 35% of the sites. Table 5 only includes domains that have a search method recorded as 308 domains did not have any recorded search method lowering the total domain count to 1638. The 308 domains were a result of a prior study that helped start the current study begin to track and record illicit online opioid domains. Google image searches resulted in the second most domains identified, in that 34% of the domains found by the end of the study were via a Google image search. The "Other" category includes domains found on forums or links through business to business domains. Fewer domains were found using Bing image, Millionshort, Twitter, Google, Yahoo, and Facebook than for Bing, Google image, or Duckduckgo.

Table 5. Cumulative Search Methods for 1,638 Domains

Method	Domain Hits	Percentage (%)
Bing	577	35
Google Image	563	34
Duckduckgo	237	14
Other	128	8
Facebook	31	2
Yahoo	30	2
Google	24	1
Twitter	23	1
Millionshort	20	1
Bing Image	5	0

Overall, Bing text searches resulted in the most domains found as it was the first search engine used. Google image search was not as utilized at the beginning of the study but increased significantly by the third month of the study and resulted in more domains found. By January, Google image searches were utilized ten times more, resulting in more recorded domains than previously. Duckduckgo resulted in more domains in July and August than at the conclusion of the study due to focusing on Google image search techniques more than Duckduckgo. Facebook, Yahoo, Google text searches, Twitter, Millionshort, and Bing image searches did not result in many domains as seen in Table 6. Figure 2 shows the prevalent hits from Bing and Google image search as the top two methods resulting in the most illicit domains.

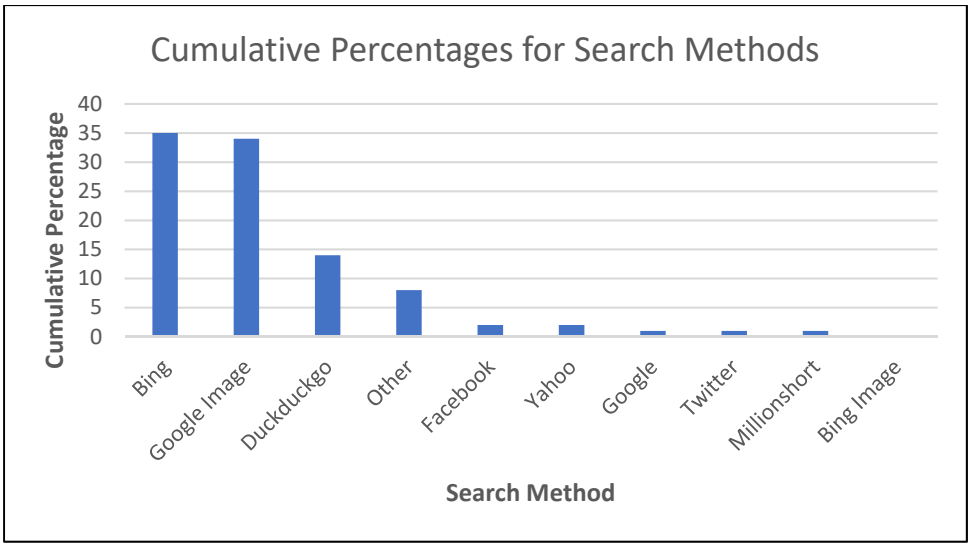


Figure 2. Cumulative Search Method Percentages of Sites Found by Search Method

Table 6. Cumulative Total Percentages Domains by Search Method

Method	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
Bing	60.8	47.6	38.9	36.7	35.9	35.4	35.2
Google Image	3.5	19.2	30.4	33.9	35.0	34.5	34.4
Duckduckgo	24.9	20.3	16.2	15.3	14.7	14.5	14.5
Other	3.6	6.0	7.5	7.4	7.9	7.8	7.8
Facebook	2.2	1.6	1.8	1.8	1.7	1.8	1.9
Yahoo	3.6	2.6	2.1	1.9	1.9	1.8	1.8
Google	1.4	1.0	1.4	1.3	1.3	1.4	1.5
Twitter	0	0	0	0	0	1.2	1.4
Millionshort	0	1.7	1.4	1.3	1.2	1.2	1.2
Bing Image	0	0	0.3	0.3	0.3	0.3	0.3

Image Searches Versus Text Searches

As it became more difficult to find new illicit opioid selling domains, Google and Bing image searches were implemented. The use of image searches is not as well-known as keyword searches; however, this form of searching is available to the average person

without any extra software or fees. The percent of sites found by keyword and image searches is shown in Table 7. No conclusions should be drawn about the prevalence of sites found through the various search engines and social media platforms as the number of searches per method was not equal and once a site was found, it would only be recorded once. Therefore, if one domain was found using Bing the same domain found on Google would not be recorded twice. These results do illustrate how easy it is for to find illicit drugs for sale online, through multiple avenues and technological skill levels.

Table 7. Cumulative Text versus Image Searches

Type of Search	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
Text Search	97.45	84.80	74.63	71.51	70.36	70.72	70.81
Image Search	2.55	15.20	25.37	28.49	29.66	29.28	29.19

Keyword Social Media Searches

The easiest and fastest way to spread information is through social media. Through Facebook and Twitter, over 1350 posts, and pages were found pertaining to opioids. By directly searching domain names from the master sheet, posts that were promoting those domains were identified. In addition, opioid keywords were used to search Facebook pages and keywords preceded by a hashtag such as #opioids, #U-47700, and #oxicodone were used for Twitter. Many of the illicit opioid selling domains linked to either a Facebook or a Twitter page Approximately 69.37% of the total domains found in this project either had social media pages or were referenced in posts or comments. Over 60 % found illicit opioid selling domains had social media ties. Social media is one

of the largest forum platforms of sharing information and it is being utilized in the sale of illicit drugs.

Regional Registry

Regional Internet Registry (RIR) refers to regional location where the domain registrar is located. The American Registry for Internet number (ARIN) includes Canada and the United States. The data indicates that 67% of the 1946 domains found in this project are registered in the ARIN region (Table 8 and Figure 3). However, there are a significant number of domains registered in other regions of the world. For instance, 24.39% of the domains are registered in the Reseaux IP Européens Network Coordination Centre. The RIPE NCC includes Europe and parts of the Middle East. RIPE NCC region. As searches were run using English terms, it is reasonable to expect that most sites identified in this study would be registered in the ARIN and RIPE NCC regions. Less than 7.49% of the total illicit domains recorded in the Asia Pacific Network Information Centre (APNIC) which includes most of Asia, islands in the Pacific as well as Australia. Less than 1% of the sites were registered in the Latin American and Caribbean (LACNIC) region, which includes Central America and South America, as well as the African Network Information Center (AFRINIC), which is the entire continent of Africa, making their contribution to the Clearnet distribution of opioids identified in this project insignificant.

Table 8. Percent of Sell Sites Registered in Various Regions of the World

Region	Domain Hits	Total Domains	Percentage (%)
ARIN	1306	1946	67.11
RIPE NCC	476	1946	24.46
APNIC	144	1946	7.40
LACNIC	17	1946	0.87
AFRINIC	3	1946	0.15

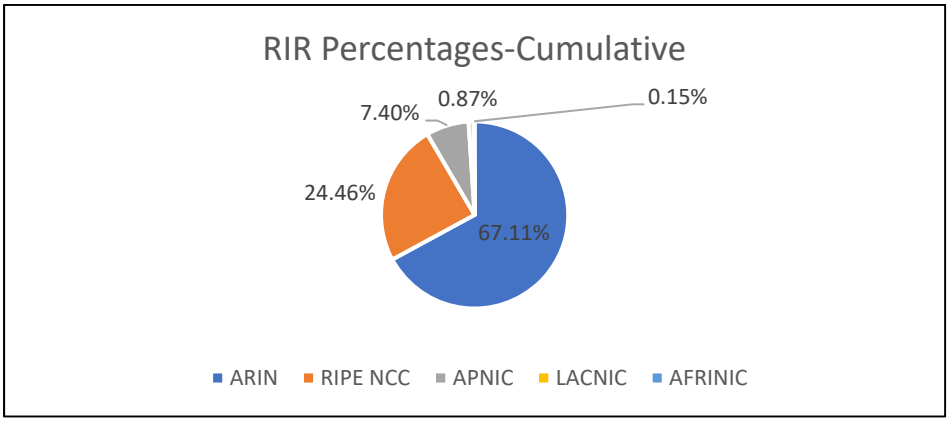


Figure 3. Regions Internet Registry of English Sell Sites

As shown in Table 9 the distribution of regions where the websites were registered was consistent over the study with little to no increase in percentages per RIR. In fact, LACNIC and AFRINIC remained the same over the 20-week collection period. ARIN and RIPE NCC fluctuated throughout the study, however, the distribution of the regional registration remained relatively constant over the 20 weeks of the data collection, varying by only 1-2%, as shown in Table 9.

Table 9. Cumulative Data for RIR percentages

RIR	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
ARIN	68	68	69	67	68	67	67
RIPE NCC	24	24	26	25	25	24	24
APNIC	7	7	8	7	8	7	7
LACNIC	1	1	1	1	1	1	1
AFRINIC	0	0	0	0	0	0	0

Registrar Information

Each domain registrar was recorded through the DNSQuery (dnsquery(.)org and ipinfo(.)io) websites to gather information such as the registrar's name, IP address, registrar's location, and the registrar's email and phone number. Table 10 lists the registrars hosting more than 30 of the illicit domains. At the end of the study, more of the domains were hosted on Namecheap than the other registrars with NameSilo and Shinjiru as second and third respectively. PDR Ltd. Public Domain Registry, GoDaddy, Hostinger, NetEarch, Hostinger Concepts B.V.-open provider, Guangdong Nicenic Technology Co., Ltd., Dreamscape, ERANET, Tucows, and WEBCC all hosted over 30 domains. The registrar data are depicted graphically in Figure 4.

Table 10. Total Cumulative Percentages of Top Host Registrar Information

Registrar	Domain Hits	Domain Total	Percentage (%)
Namecheap	345	1946	17.73
NameSilo	306	1946	15.72
Shinjiru	167	1946	8.58
PDR Ltd. Public Domain Registry	130	1946	6.68
GoDaddy	113	1946	5.81
HOSTINGER	92	1946	4.73
NetEarth	62	1946	3.19
Hosting Concepts B.V-Openprovider	52	1946	2.67
Guangdong Nicenic Technology Co., Ltd.	46	1946	2.36
Dreamscape	45	1946	2.31
ERANET	43	1946	2.21
Tucows	36	1946	1.85
WEBCC	32	1946	1.64

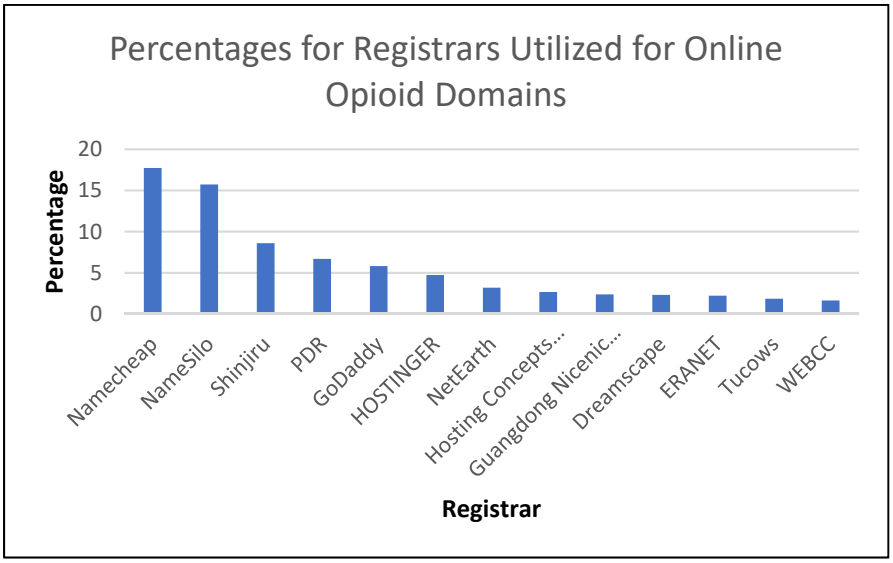


Figure 4. Cumulative Domain Host Percentages

The number of illicit opioid selling domains for each registrar was tracked over time (Table 11). Initially, more sites were hosted on NameSilo, however, over time, this changed to more sites being hosted on NameCheap. Shinjuru was consistently the third most utilized registrar throughout the study. PDR Ltd. Public Domain Registry, Hosting Concepts B.V-Openprovider, NetEarth One Inc., Tucows, WEBCC, and GoDaddy increased in utilization slightly overtime while Hostinger, Dreamscape ERANET, and Guangdong Nicenic Technology Co., ltd. decreased slightly over time. Other registrars were monitored, however, only the registrars with hosting over 30% of the illicit opioid selling domains are discussed.

Table 11. Cumulative Percentages for Host Names Over Time

Host Name	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
NameCheap	16.15	15.88	16.89	17.42	17.65	17.73	17.73
NameSilo	16.33	16.16	15.19	14.49	15.72	15.72	15.72
Shinjiru	10.45	9.61	9.33	9.01	8.72	8.61	8.58
PDR Ltd. Public Domain Registry	5.53	5.79	6.26	6.73	6.74	6.65	6.68
GoDaddy	4.74	5.45	5.69	5.59	5.64	5.82	5.81
HOSTINGER	4.83	5.32	4.95	4.83	4.80	4.74	4.73
NetEarth One Inc.	2.37	2.73	2.84	3.26	3.19	3.20	3.19
Hosting Concepts B.V- Openprovider	2.37	2.73	2.79	2.71	2.66	2.68	2.67
Dreamscape	2.81	2.45	2.28	2.17	2.35	2.32	2.31
ERANET	2.90	2.59	2.45	2.33	2.25	2.22	2.21
Guangdong Nicenic Technology Co., Ltd.	2.46	2.52	2.28	2.17	2.09	2.06	2.06
Tucows	1.58	1.91	1.88	1.84	1.88	1.86	1.85
WEBCC	1.14	1.50	1.65	1.63	1.67	1.65	1.64

Domain Longevity

Some of the illicit opioid domains went offline during this study. It is interesting to note that some of the offline domains would become active again (Table 12). The total domains that went offline was 486 (24.97%), while 143 of the domains came back online. At the end of the study, 7.35% of the total domains were back online. In total, 67.68% of the 1946 domains were online at the end of this study when comparing offline, online, and back online cumulatively. There are several reasons why a site might go offline (Figure 5). It could be the domain fees were not paid, they were removed by the owner, the domain changed hosts for another host registrar, or it was removed by the registrar. When only comparing offline and back online sites against each other, consistently, offline and back online sites remained around 75% and 25% respectively indicating that more domains stayed offline than were offline temporarily (Table 13).

Table 12. Percentage of Domains Offline, Online, Or Back Online

Status of Domains	Domain Hits	Total Domains	Percent (%)
Online	1317	1946	67.68
Offline	486	1946	24.97
Back Online	143	1946	7.35

Table 13. Cumulative Online Status Between Offline and Back Online

Status	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
Offline	76	71	71	76	78	77	25
Back Online	24	29	29	24	22	23	7
Online							67.68

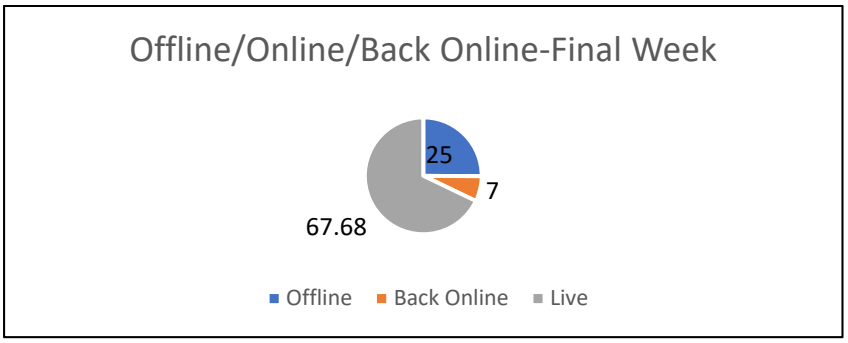


Figure 5. Final Cumulative Status of Monitored Illicit Domains

Each registrar with a domain that went offline was averaged to obtain the overall average number of days a domain was removed per registrar. Table 14 shows the breakdown of each host and the number of domains that were online or offline at the end of the study. N/A listed in Table 14 indicates the number of domains that did not have any registrar information indicating the online or offline status of the domain from the DNS query. Of the pages that went offline, domains registered with GoDaddy had the

greatest longevity. Figure 6 indicated how many domains are online or offline for each registrar for the last and cumulative week of the study. Most of the commonly utilized registrar's illicit domains have domains offline

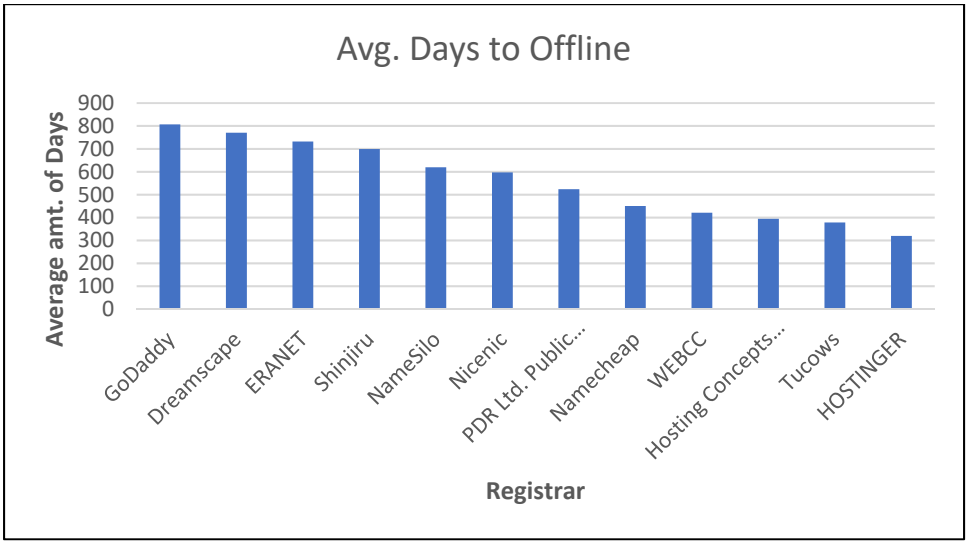


Figure 6. Average Days to Offline per Registrar

Table 14. A Breakdown of Final Cumulative Online/Offline Domains per Host

Host	Online Domains	Offline (Down) Domains	N/A	Total	Avg. Days to Offline
Namecheap	236	71	38	345	450.47
NameSilo	243	53	10	306	619.40
Shinjiru	146	15	6	167	698.75
PDR Ltd. Public Domain Registry	91	37	2	130	523.63
GoDaddy	98	9	6	113	806.55
HOSTINGER	81	10	2	93	319.50
Hosting Concepts B.V- Openprovider,	35	14	3	52	394.40
Nicenic	29	7	10	46	597.00
Dreamscape	40	3	2	45	770.00
ERANET	39	3	1	43	731.67
Tucows	26	6	4	36	378.50
WEBCC	30	2	0	32	421.00

Table 14 shows cumulatively at the end of the study, GoDaddy took the longest for a domain to go offline at over 806.55 days on average. Within the range study, one GoDaddy registered domain was live for 3880 before going offline. All GoDaddy domains listed in the CFRL master sheet documented illicit opioid activity. The registrar that had the shortest domain life was Open Provider in that it only took 319.5 days on average for a domain to go offline. Tuscows had, on average, of 378.5 days for a domain to go offline. Most registrars had one to two years on average for domains to go offline except for GoDaddy.

Location of Registrars

Location of the registrar is listed in Table 15. From the data in Figure 7, most of the domains are registered in San Francisco, California with New York City, New York a close second. Most of the locations of registrars were in the US because the searches were done in English. However, there were still significant number of domains located in Amsterdam, Toronto, London, Paris, Moscow, Craiova, Bulgaria, Cyprus, Malaysia, and the Netherlands. There was only a fraction of Chinese or Asian countries listed as a location.

Table 15. Location of Domain Registry Percentages

Domain Registrar Location	Domain Hits	Total Domain	Percent (%)
San Francisco, California, United States	232	1946	11.92
New York City, New York, United States	162	1946	8.32
Chicago, Illinois, United States	103	1946	5.29
San Jose, California, United States	101	1946	5.19
Los Angeles, California, United States	92	1946	4.73
Coffeyville, Kansas, United States	58	1946	2.98
Amsterdam, North Holland, Netherlands	51	1946	2.62
Houston, Texas, United States	41	1946	2.11
London, England, United Kingdom	36	1946	1.85
Craiova, Dolj, Romania	35	1946	1.80
Sofia, Sofia-Capital, Bulgaria	34	1946	1.75
Toronto, Ontario, Canada	32	1946	1.64
Phoenix, Arizona, United States	28	1946	1.44
Larnaca, Larnaka, Cyprus	26	1946	1.34
Paris, Île-de-France, France	23	1946	1.18
Moscow, Moscow, Russia	23	1946	1.18
Kuala Lumpur, Kuala Lumpur, Malaysia	23	1946	1.18

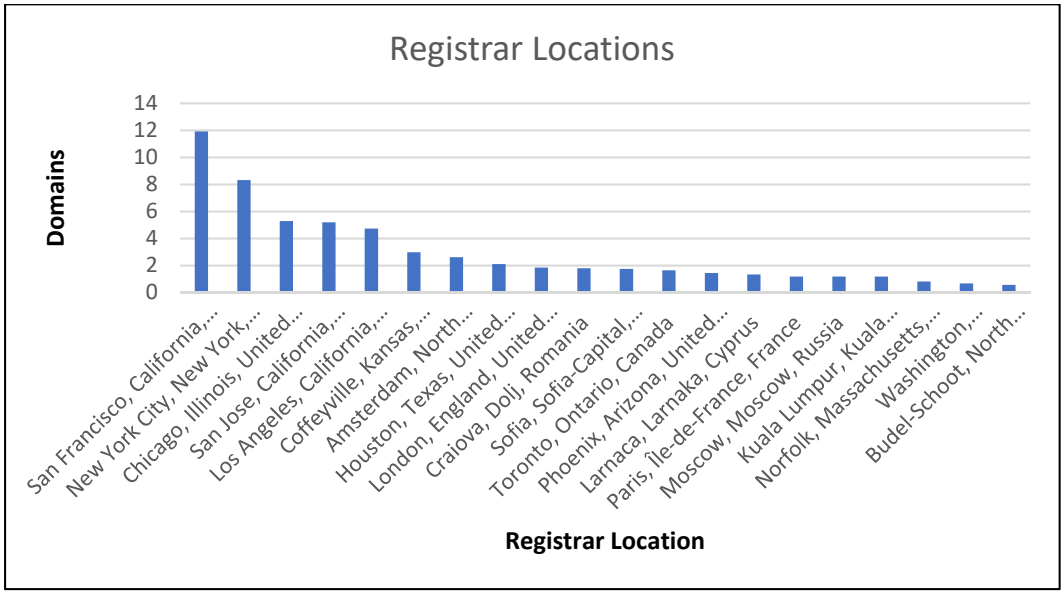


Figure 7. Data Indicating the Number of Illicit Sell Sites per Domain Location

Over the 20-week period, the top domain registrar locations were monitored to analyze if the distribution of registrar locations was constant (Table 16). San Francisco, CA in the United States is the location with the highest number of illicit opioid selling

sites beginning with 16% of the sites being registered there. Even though the number of domains using San Francisco decreased to 12% by the end of the 20-week study, that location particularly was still the most used locations for domain registry. New York City was the second location most seen in registrar locations, with Chicago, IL in third.

Table 16. Total percentages of Popular Domain Registrar Locations

Domain registrar location	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
San Francisco, California	14	12	12	12	12	12
New York City, New York,	8	9	9	9	9	8
Chicago, Illinois	3	6	6	5	5	5
Los Angeles, California	6	6	5	5	5	5
San Jose, California	3	3	4	5	5	5
Coffeyville, Kansas	4	3	3	3	3	3
Amsterdam, Netherlands	2	2	2	3	2	3
Toronto, Canada	1	2	2	2	2	2
Houston, Texas	2	2	2	2	2	2
London, England	2	2	2	2	2	2
Craiova, Romania	2	2	2	2	2	2
Sofia, Bulgaria	2	2	2	2	2	2
PARIS, FRANCE	1	1	1	1	1	1
Moscow, Russia	1	1	1	1	1	1
Phoenix, Arizona	1	1	1	1	2	1
Larnaca, Cyprus	1	1	1	1	1	1
Kuala Lumpur, Malaysia	1	1	1	1	1	1

Chat Services

Many of the illicit opioid selling sites incorporate a chat service, offering immediate help to potential customers. Using a chat service allows the consumer to communicate without having to exchange personal information. The purpose of documenting chat services is to determine which services are commonly utilized and notify the service provider that the domain is violating the terms and conditions set by the chat service (Table 17).

Over 17 different chat services are used by the illicit sell sites, however only the top nine most utilized services were identified and recorded. In Figure 8, 20% of the sites use the chat service Tawk(.)to. The second most used chat service was Mylivechat and Tidio was third. Not every illicit site has a chat service. When starting the study in July, only 3.9% of the sites used Tidio but that has since increased to over 6%. Seven of the 17 chat services were closely monitored due to their higher usage on illicit domains. Since the study, some of the domains have changed chat services, decreasing the number of domains using Tawk(.)to. Consistently through the study, the top two chat services steadily decreased and the number of sites using Tidio began to climb (Table 18). The number of sites using Tidio had increased by 60% from the beginning to the end of the study, while most of the other chat services had remained consistent throughout.

Table 17. Chat Services Recorded from Illicit Opioid Sell Sites

Service	Domain Hits	Total Domains	Percentage (%)
Tawk(.)to	407	1946	20.91
Mylivechat	173	1946	8.89
Tidio	120	1946	6.17
Jivochat	56	1946	2.88
Smartsupp	55	1946	2.83
Crisp	53	1946	2.72
Livechat	45	1946	2.31
Zendesk	39	1946	2.00
Formilla	18	1946	0.92

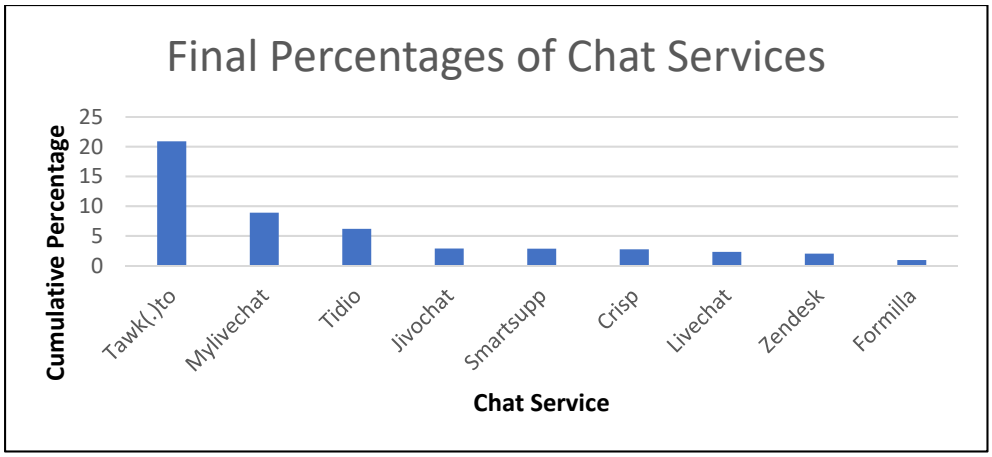


Figure 8. Chat Service Data

Chat services are an example of illicit opioid selling sites using legitimate companies for illegitimate purposes. Chat services allows sellers and consumers to chat online quickly allowing a quick exchange of illicit opioids faster than if one purchased illegal controlled substance on the street.

Table 18. Chat Service Data per Month

Service	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
Tawk(.)to	22.48	22.84	21.90	21.43	21.04	20.98	20.91
Mylivechat	12.12	10.77	9.67	9.28	9.03	8.92	8.89
Tidio	3.95	4.98	6.09	6.02	6.16	6.13	6.17
Jivochat	2.46	2.32	2.56	2.82	2.77	2.89	2.88
Smartsupp	2.37	2.18	2.50	2.77	2.77	2.78	2.83
Crisp	1.67	1.91	2.16	2.28	2.61	2.73	2.72
Livechat	3.34	2.73	2.56	2.44	2.35	2.32	2.31
Zendesk	2.81	2.52	2.10	2.01	2.04	2.01	2.00
Formilla	0.79	0.95	0.91	0.98	0.94	0.93	0.92

Payment Methods

Many domains list the payment methods consumers can use to purchase illicit online opioids. The top three payment methods used on illicit opioids selling sites are Bitcoin, Western Union, and MoneyGram followed by VISA, Mastercard, and PayPal (Figure 9). Noting the payment methods accepted by a website helps to determine if it is illicit or not. For instance, legitimate online chemical companies do not accept Bitcoin or any crypto currency as a form of payment for chemical supplies.

Table 19. Payment Type Domain Hits

TYPE	Domain Hits	Total Domains	Abbreviation
Bitcoin	1038	1946	btc
Western union	722	1946	WUn
Money gram	584	1946	MGm
VISA	426	1946	Vis
Mastercard	420	1946	Mas
Paypal	384	1946	PPl
Bank Transfer	275	1946	Btr
Cash App	194	1946	CAp
American Express	162	1946	Aes
Discover	151	1946	Dis
Gift cards	147	1946	GCs
Zelle	133	1946	Zel
RIA Money	73	1946	RMy
cash on delivery	69	1946	cod
Walmart 2 walmart	47	1946	W2W
Amazon	43	1946	Amp
stripe	38	1946	stripe
Maestro	36	1946	mst
Litecoins	31	1946	Ltc
Wire Transfer	31	1946	wtf
Google Pay	26	1946	Gpy
Skrill	25	1946	SKr
Ethereum	19	1946	Eth
Apple Pay	16	1946	Apy

Bitcoin is the most common payment method, used by 1038 domains of the total 1946 shown in Table 19. There can be multiple payment methods listed on one domain, therefore the total number of payment methods listed is greater than the total number of sites on the Master sheet. Cash apps like CashApp and Zelle as well as bank transfers are commonly accepted by illicit domains. Payment methods offered by large corporations like Amazon, Walmart, and Apple Pay are being accepted on illicit opioid sell sites. Many of these corporations have terms and conditions that restrict their services from being used for illicit purposes and the company has full right to suspend an account if caught doing so. Twenty-seven other payment methods were monitored throughout the study but were not found to be as commonly utilized and advertised on illicit opioid sell sites.

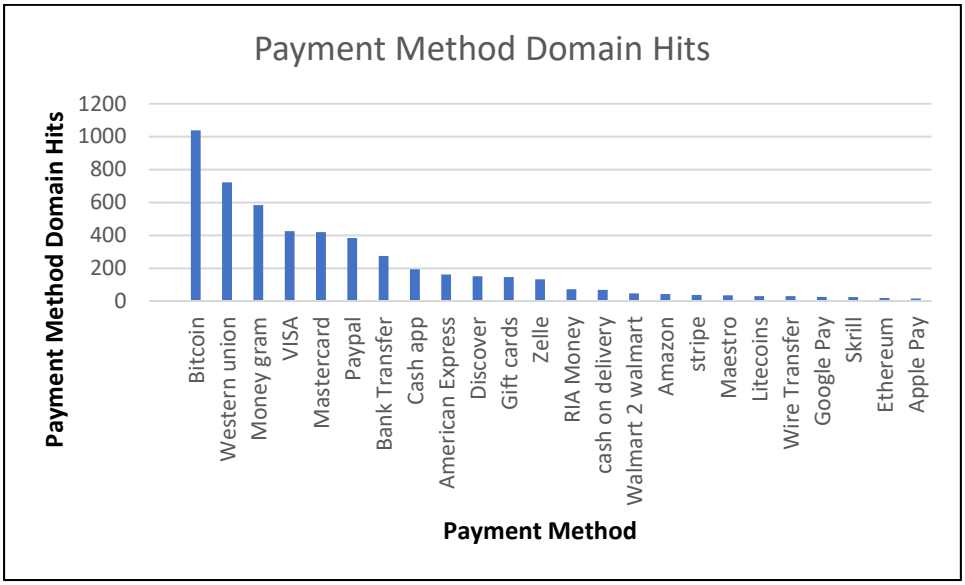


Figure 9. Payment Methods Commonality on Illicit Opioid Sell Sites

Email Domains

Email addresses aid in researching connections in the illicit opioids selling sites. Email addresses can be searched in search engines such as Bing and Google to identify other illicit opioid selling sites with the same contact information, connecting multiple sites to one network. Email address domains also have terms of use that prohibit the use of their service for illegal activities. The email domains used by the illicit opioid selling sites are shown in Figure 10. Nearly 67% of the sites list a custom domain, often containing the name of the website in the email address. For example, the site bitcoindrugstore(.)com has the contact email support(@)bitcoindrugstore(.)com. Custom email addresses are easy to obtain and easy to use.

Gmail accounts were listed for 28% of sites, and was second after custom domains, while Protonmail was third at only 2.24% of total email domains (Table 20). Other large free email services like Yahoo, Outlook, and Hotmail, were used by less than 2% of the illicit opioid selling sites that listed an email address. Protonmail boasts of private emailing and searching which could indicate why it is third most utilized email domain used by illicit opioid selling sites.

Table 20. Email Domain Usage Percentages

Email Domains	Domain Hits	Total Domains w/ Email	Percentage (%)
(@)Custom Domain	1060	1561	67.91
Gmail	451	1561	28.89
Protonmail	35	1561	2.24
Yahoo	8	1561	0.51
Outlook	5	1561	0.32
Hotmail	2	1561	0.13

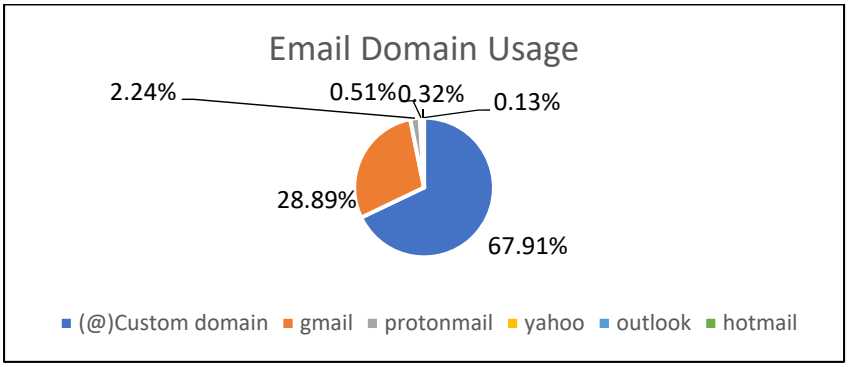


Figure 10. Email Domain Usage

The distribution of email domains remained consistent throughout the data collection with custom domains remaining between 67% and 68% of the total email addresses. Email domains are another example of how illicit opioid selling sites use legitimate online services to buy and sell illicit opioids online Table 21.

Table 21. Total Percentages Over 20 Weeks for Email Domains

Email Domain	July (%)	August (%)	September (%)	October (%)	November (%)	December (%)	January (%)
(@)Custom Domain	67	68	68	68	68	68	68
Gmail	29	29	29	29	28	28	29
Protonmail	3	2	2	2	2	2	2
Yahoo	1	1	1	1	1	1	1
Hotmail	0	0	0	0	0	0	0
Outlook	0	0	0	0	0	0	0

CONCLUSION

The opioid crisis beginning in the 1990s has grown exponentially since then. The over prescribing of opioids such as oxycodone, the misinformation on opioid addiction, and tolerance led to an epidemic. Once patients were initially addicted to prescription opioids, many found tolerance to the drug had increased and a more potent option was needed to obtain the same level of euphoria. The release of abuse resistant prescription opioids and the increase of patients addicted to opioids searching for a better and more intense high contributed to the increase of heroin use in the early 2010s. From heroin to fentanyl, illicitly manufactured fentanyl has become the next wave of the opioid crisis.

A total of 1946 illicit online domains were found. Most of the total domains were registered in the ARIN region. The most utilized search method was Bing resulting in the most recorded domains; however, this could be skewed due to domains only being recorded once and Bing was the first search engine used for any keyword searches. The most utilized registrar of the total domains was Namecheap with the registrar with the longest average amount of days for a domain to go offline being GoDaddy. San Francisco, CA was the most recorded registrar location. Tawk(.)to and Bitcoin were the most recorded chat service and payment method.

The opioid crisis has been exacerbated by the presence of illicit opioid selling sites that use legitimate companies in the sale of illicit opioids. The use of legitimate online service providers to promote the sale of illicit opioids is extremely common on the Clearnet as documented in this study and should be further investigated with the goal of developing methods to remove illicit domains, place disclaimers on search engines and social media, and educate the public on the dangers of purchasing drugs online.

Trends pertaining to the use of legitimate sites by illicit drug selling sites were studied. The sites remain online for long periods. They consistently utilize common registrars, chat services, email domains, payment methods, and search methods to sell illicit drugs online. Future work with this topic will include collaborating with internet companies to develop methods that limit access to illicit drug selling sites through search engines, remove illicit domains, put disclaimers on search engines and social media, and educate the public on the dangers of purchasing drugs online.

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APPENDIX A

OPIOID KEYWORDS

Tables A1-A6 show categories of opioids and synonyms per category. Synonyms are a mixture of slang terms, brand names, chemical formulas, and common misspellings of each opioid.

Table A1. Opioids Keywords Lists per Opioid Category

Buprenorphine	C29H41NO4	Codeine	6-Acetylcodeine
	Bupe		6-Methoxymorphine
Hydrocodone	Dicodid		Actacode
Hydromorphone	Dilaudid		Actacode Linctus
	Exalgo		Aspirin Codeine
	Exalo		C17H20N2S
	Hydrostat IR		C18H23NO3
Meperidine	Demerol		Codeine Cough Syrup
Morphine	Kadian		Codeine Phosphate
	C17H19NO3		Codeine Phosphate Hemihydrate
	C25H33NO4		Codeine Phosphate Syrup
	Etorphine		Codeine Sulfate
	Etrophine Hydrochloride		Codeine Syrup
	MS contin		Cody
	Oramorph		Cough Syrup
Oxymorphone	C17H19NO4		Dihydrocodeine
	Blue heaven		Doors
	Mrs O		Fours
	Octagons		Lean
	Opana		Loads
	Oranges		Norcodeine
	Pink heaven		Paracodin Syrup
	Pink lady		Promethazine Codeine
	Pink O		Promethazine Codeine Cough Syrup
	Stop signs		Purple Cough Syrup
	The O bomb		Purple drank
Tapentadol	C14H23NO		Schoolboy
	Nucynta		The slurr
Thebaine	C19H21NO3		The syrup
Tramadol	C16H25NO2		Ultracod

Table A2. Heroin Keywords

(Dual) Acetylated Morphine	Diacetylmorphine hydrochloride
3,6-Diacetylmorphine	Diamorfina (Spanish)
Acetomorphine	Diamorphine
Antifreeze	Diamorphine hydrochloride
Big H	Dope
Black Suff	EINECS 209-217-7
Black Tar	Fairy dust
Blow Dope	Golden Girls
Brown Heroin	Heaven Dust
Brown Sugar	Heroin Hydrochloride
C21H23NO5	Hot Dope
C21H23NO5 HCL	Mexican Black Tar
CAS 1502-95-0	Mexican Brown
CAS 561-27-3	Mexican Horse
Cement	Morphinan
Charlie	Morphine Diacetate
Cheeze	Smack
China cat	White Horse
China White	White junk
Diacetyl morphine	Wite nurse

Table A3. Oxycodone Keywords

Blues	Noroxycodone Hydrochloride	OxyFast
CAS 76-42-6	OC	Oxyneo
Dihydro-14-hydroxycodeinone	Ossicodone	Oxynorm
Dihydrohydroxycodeinone	Oxaydo	Roxicodone
Dihydroxycodeinone	Oxicodona-Spanish	Targiniq ER
Dinarkon	Oxicone	Tekodin
EINECS 200-960-2	Oxiconum	the 40s
Endodan	Oxy	the 80s
Endone	Oxycodon	The Ox
Eucodal	Oxycodone Hydrochloride	Xatampza ER
Eukodal	Oxycodonum	Xtampza
Hillbilly heroin	Oxycone	Xtampza ER
Kickers	OxyContin	
M-30's	Oxycotin	

Table A4. Compound Opiates Keywords

Compounds	512 pills	Oxycodone Hydrochloride and Acetominophen
	Anexsia	Hydrocodone and Acetominophen
	Aspirin-Codeine	Codeine and Aspirin
	Co-Codamol	Codeine and Paracetamol (Mersyndol)
	Co-Gesic	Hydrocodone and Acetominophen
	Ecodan	Oxycodone and Aspirin
	Embeda	Morphine and Naltrexone
	Endocet	Oxycodone and Acetominophen
	Hycet	Hydrocodone and Acetominophen
	Hycodan	Hydrocodone and Homatropine
	Hydromet	Hydrocodone and Homatropine
	Ibudone (Ibudon)	Hydrocodone Bitartrate and Ibuprofen
	Liquicet	Hydrocodone Bitartrate and Acetominophen
	Lorcet	Hydrocodone and Acetominophen
	Lorcet plus	Hydrocodone Bitartrate and Acetominophen
	Lortab	Hydrocodone and Acetominophen
	Maxidone	Hydrocodone Bitartrate and Acetominophen
	Norco	Hydrocodone and Acetominophen
	Oxycet	Oxycodone and Acetominophen
	Percocet	Oxycodone and Acetominophen
	Percodan	Oxycodone and Aspirin
	Primlev	Oxycodone and Acetominophen
	Reprexain	Hydrocodone and Ibuprofen
	Rezira	Hydrocodone and Pseudoephedrine
	Roxicet	Oxycodone and Acetominophen
	Roxiprin	Oxycodone and Aspirin
	TrussiCap, Trussionex	Hydrocodone and Chlorpheniramine ER
	Tuzistra XR	Codeine and Chlorpheniramine
	Tylenol-Codeine	Codeine and Acetominophen
	Tylox	Oxycodone and Acetominophen
	Vicodin	Hydrocodone and Acetominophen
	Xolox	Oxycodone and Acetominophen

Table A5. Fentanyl Keywords

2,2-difluorofentanyl	Allylfentanyl	C22H27FN2O2	Dragon
2,5-Dimethylfentanyl	a-Methylacetylfentanyl	C22H28N2O	Duragesic
3-Allylfentanyl	a-Methylbutyrfentanyl	C23H30N2O	Fentanyl
3-methyl-benzylfentanyl	a-Methylfentanyl	C24H26N2O2	Fentanyl Analog
3-Methylfentanyl	a-Methyl-ß-hydroxyfentanyl	C24H30N2O2	Fentanyl Citrate
3-Methylthiofentanyl	a-Methylthiofentanyl	C24H30N2O3	Fentanyl Sublingual Tablets
3-Mirfentanyl	Apache	C24H32N2O	Fenty
3-Phenylpropanoylfentanyl	Benzodioxolefentanyl	C27H28N2O3	Fluorobutyrfentanyl
4-Chloride Isobutyryl fentanyl	Benzoylfentanyl	C27H36N2O HCL	Fluorofentanyl
4-FIBF	Benzylfentanyl	Carfentanil	Fluoroisobutyfentanyl
4-Methoxybutyrfentanyl	Brifentanil	Carfentanyl	fu-f
4-Methoxymethylfentanyl	Brifentanyl	China Girl	Furanylethylfentanyl
4-Methylphenethylacetylfentanyl	Butyrfentanyl	China Town	Furanylfentanyl
4-Phenylfentanyl	C16H22Cl2N2O	Chloroisobutyrylfentanyl	Goodfellas
Abstral	C17H24N2O3	Cyclopentylfentanyl	Great Bear
Acetylfentanyl	C20H28N2O5	Cyclopentylfentanyl Hydrochloride	He-Man
Acrylfentanyl	C20H29FN6O3	Dance Fever	Isobutyrylfentanyl
Actiq	C21H32N6O3	Dargon's breath	Isofentanyl
AH-7921	C22H26N2O	Difluorofentanyl	Jackpot
Alfentanyl	C22H27FN2O	Dimethylfentanyl	King Ivory

Table A6. Fentanyl Keywords Continued

Lofentanyl	Ortho-isopropylfuranylfentanyl	Sublimaze
Meta-fluorofentanyl	Ortho-methoxyfuranylfentanyl	Subsys
Meta-fluorofentanyl Hydrochloride	Ortho-methylfuranylfentanyl	Sufentanil
Methoxyacetylfentanyl	Para-chlorisobutyryl Fentany	Tango and Cash
Methylbutyrfentanyl	Para-chlorofuranylfentanyl	Tetrahydrofuranylfentanyl
Methylfentanyl	Para-fluorofuranylfentanyl	Tetramethylcyclopropylfentanyl
Methylfuranylfentanyl	p-Cl-Fu-F	Thienyl fentanyl hydrochloride
Methylthiofentanyl	Perc-aPop	Thiofentanyl
Mirfentanyl	p-F-Fu-F	Thiofentanyl Hydrochloride
Murder Eight	Phenylpropanoylfentanyl	trans-phenylcyclopropyl-norfentanyl
N-Methylcarfentanil	Pyridin-4-ylethyl-norfentanyl	Trefentanil
N-Methylcarfentanyl	R-30490	Trefentanyl
Ocfentanil	R39209	u-47700
Ocfentanyl	Remifentanil	U-48800
Ohmefentanyl	Remifentanyl	U-49900
o-iPr-Fu-F	ß-Hydroxy-3-methylfentanyl	U-50488
o-Me-Fu-F	ß-Hydroxy-4-methylfentanyl	U-51754
o-MeO-Fu-F	ß-Hydroxyfentanyl	U-69593
Oral transmucosal lozenge	ß-Hydroxythiofentanyl	Valerylfentanyl
Orthofluorofentanyl	ß-Methylfentanyl	Wildnil