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What you can't buy, can't kill you

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Summary of the Project

Goal, and Objectives

Goal: Develop methods to *Discover, Disrupt, and Disseminate* information about the illicit fentanyl market. Methods for disruption efforts will focus on two branches: Distribution and Small Market Vendors.

Objectives: The objectives of the proposed research are to build cyber intelligence methods to disrupt two branches of the illicit fentanyl market on the Opennet: Distribution and Small Market Venders. The first objective is to develop lab techniques, such as Visual Keyword Cueing, combined with the UAB Computers Forenics Research Laboratory (CFRL) developed tool, *SearchCrawler*, used identify both bulk and small volume suppliers of non-pharmaceutical fentanyls (NPF). Application of these methods by law enforcement agencies will allow them to identify and disrupt shipment of illicit goods into the US or block access to precursor chemicals used in the manufacturing of synthetic opioids. The second objective is to use the same methods for social network discovery and analysis techniques to identify the social network locations, social cataloging companies or a business-oriented social networking companies where drug conversations are likely to occur and find accounts selling in these sites. Methods will be developed to disrupt the street level distribution of NPFs by deleting the accounts. The final objective is to develop strategies to identify emerging trends in online sales of opioids on the open web in order to quickly block sellers access to otherwise legitimate internet services, because *What You Can't Buy, Can't Kill You*.

Research Questions

The opioid crisis started with the overpromotion and overprescribing of prescription opioids, transitioned through a heroin wave, then fentanyl and fentanyl analogs. The total deaths attributed to the opioid crisis exceeded 500,000 in the period from 1999-2019. Drug overdose deaths reached 100,000 in 2022 and are predicted to exceed 110,000 in 2023.[1]

While the public perception is that online sales of illicit drugs are only accessible through the Darknet, illicit drugs have been freely available on the open internet since the early 2000s. The Ryan Haight Online Pharmacy Consumer Protection Act (RHA; HR6353) of 2008 addressed the issue of controlled substances being sold directly to consumers online. Even so, the number of illicit drugs and non-medical prescriptions sales has increased proportionally with internet traffic. The National Association of Boards of Pharmacy found more than 1100 Clearnet domains selling pharmaceutical drugs outside of FDA regulation.[2] Cryptomarkets and online drug venders openly assure users their drugs will be shipped to their home address without interference from

customs or law enforcement.

Cryptocurrencies, such as Bitcoin, are often used for illicit drugs sales due to their ease of use, privacy, and perceived lack of traceability for sellers and purchasers. Hundreds of millions of dollars are estimated to be used annually for drug sales through cryptocurrencies.[3]

There are additional hazards to purchasing drugs online. Some online drug sites will accept payment, but never actually ship the product.[4] If the drug is even received, it may be counterfeit, unapproved, or adulterated with even more toxic substances such as the current threat, xylazine adulterated fentanyl.[5]

Traditionally, the approach to drug abuse has been through the legal system: arrest, trial, conviction, and incarceration. Harm reduction efforts have focused on the user. In this project, the focus is on the supply. The strategies developed in this research can be used by law enforcement to collect the evidence needed to convict those involved in the illegal drug trade. They also provide a timely, cost-effective alternative to the legal system. The methods developed in this project can used by private companies and institutions to quickly identify and develop protocols to block users from utilizing their services to sell illicit drugs.

The research question is addressed by developing strategies and methods that can be used by law enforcement to mitigate online sales of illicit drugs.

Research Design, Methods, and Analytical Techniques

One important aspect of the project design is combining computer forensic analysts with subject matter experts, in this case, forensic drug chemists. When the non-chemist encounters an unknown chemical descriptor, he/she works with the forensic chemists to determine if it is a fentanyl or opioid term. For each new opioid name returned through the web searches, the drug chemists will provide a list of terms that includes:

- Controlled Substance name
- Chemical names
- IUPAC name
- Formula
- CAS number
- MeSH terms (PubMed)
- Street names

Visual Keyword Cueing: Visual Keyword Cueing relies on maintaining an accurate and constantly evolving keyword list. The Google Add-On *Highlight This*, described below, highlights each keyword on a web pages that is found on a keyword list stored in the Add-On. Different lists of keywords can be assigned to each category and unique highlight colors can be assigned to each category. Because “R-30490,” “MAF,” and “U47700” are all categorized as Fentanyl keywords in our Visual Keyword Cueing system, even a non-chemically trained analyst

can immediately recognize that a web page offering these items for sale is offering fentanyl for sale. When terms that are currently not on the keyword list appear in close context to keywords that are already highlighted, these terms are referred to the forensic chemistry analysts for review and potential inclusion in the keyword list. These keywords are then used as input and scoring mechanisms by Search Crawler. There are currently more than 1400 keywords in our catalog. The keyword list includes all types of illicit drugs, including traditional drugs of abuse and novel psychoactive substances. Figure 1 illustrates the highlighting, with commercially produced opioids highlighted in orange and fentanyl terms highlighted in yellow. Using this technique non-chemist analysts can quickly identify target terms, confirming that a website should be included in a list of opioid-selling domains.

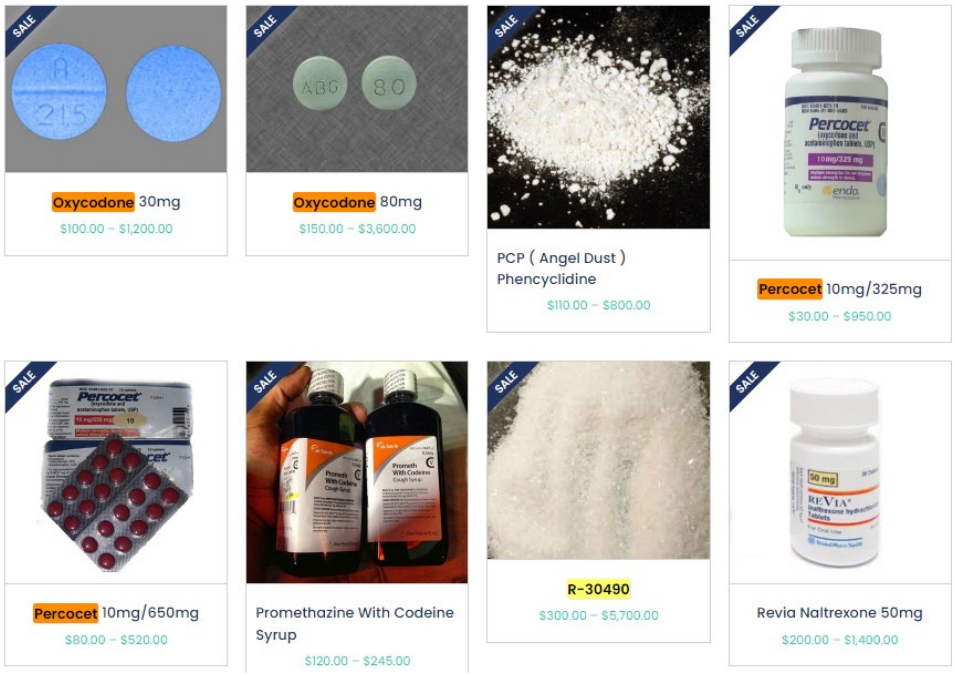

Figure 1- A "Highlight This" Visual Cueing example

Identifying illicit opioid sites through manual key word searches of common search engines: Keyword searches were run on three of the top ten popular search engines: Google, Bing, and DuckDuckGo.[6] Through experimentation, it was determined that the most successful searches combined a drug keyword with a transaction keyword or phrase. Transaction keywords were used to help select sites engaged in commerce or illicit commerce. Examples might include "free shipping" or "overnight delivery" or Bitcoin. Adding modifiers to the drug keyword, such as including a specific dosage, quantity, or both also yielded better results. "Percocet" performed less well, for example, than "Percocet 10mg."

The search terms were keyword combinations that included a drug keyword and a transaction keyword or phrase. The search results were scanned and any sites that indicate potential drug sales are visited. Relevant URLs are added to the Opioids Spreadsheet, along with the relevant

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information, including a UniqueIDentifier, DomainName, SearchEngine, Term , Page, IP address, ASN, Country Code, RIR (Regional Internet Registry), name, location, email, phone, Registrar Name, Registrar Location, Registrar Email, Registrar Phone, Up/Down/Hacked y/n/h, Drug Types, Email Address, Phone Number 1 (US), number 1, number 2, Phone Number 2 (Foreign), Fax, Address, MessengerApps, Social Media, Payment Type, Chat Service, and Notes.

Formulas were embedded in the spreadsheet were used for collecting and updating the IP address. A python script was used to determine if the collected sites were still live.

Automated searches for websites dedication to illicit opioid sales: *SearchCrawler*:

The UAB CFRL-developed tool SearchCrawler has two modes of operation. In the first mode, a term or phrase to be searched for is provided and a search engine is selected: Google, Bing, or DuckDuckGo. As the search results are returned, each of the resulting web pages is fetched and stored in the SearchCrawler database. In the second mode, a list of URLs is provided to the tool and each of the URLs is visited, again resulting in the web pages being fetched and stored in the SearchCrawler database. Each collection of web pages, either from search mode or from URL mode, is associated with a Job ID.

After a collection of web pages is gathered in a Job, the results of that job can then be analyzed through key word analysis. For each SearchCrawler topic, lists of keywords have been assembled to create "Key Word Sets." To analyze the results of jobs, one or more jobs are selected and then one or more Key Word Sets are chosen. Analysis consists of searching each previously fetched web page, using the locally stored copy of the web page, and indicating which keywords are present for which web pages that were part of this collection of jobs. Each fetched web page is "localized" so that it will properly render when the archived copy is viewed in the future, even if the original website is no longer available.

Figure 2 - Preparing to search "perc 10 sale online" in SearchCrawler

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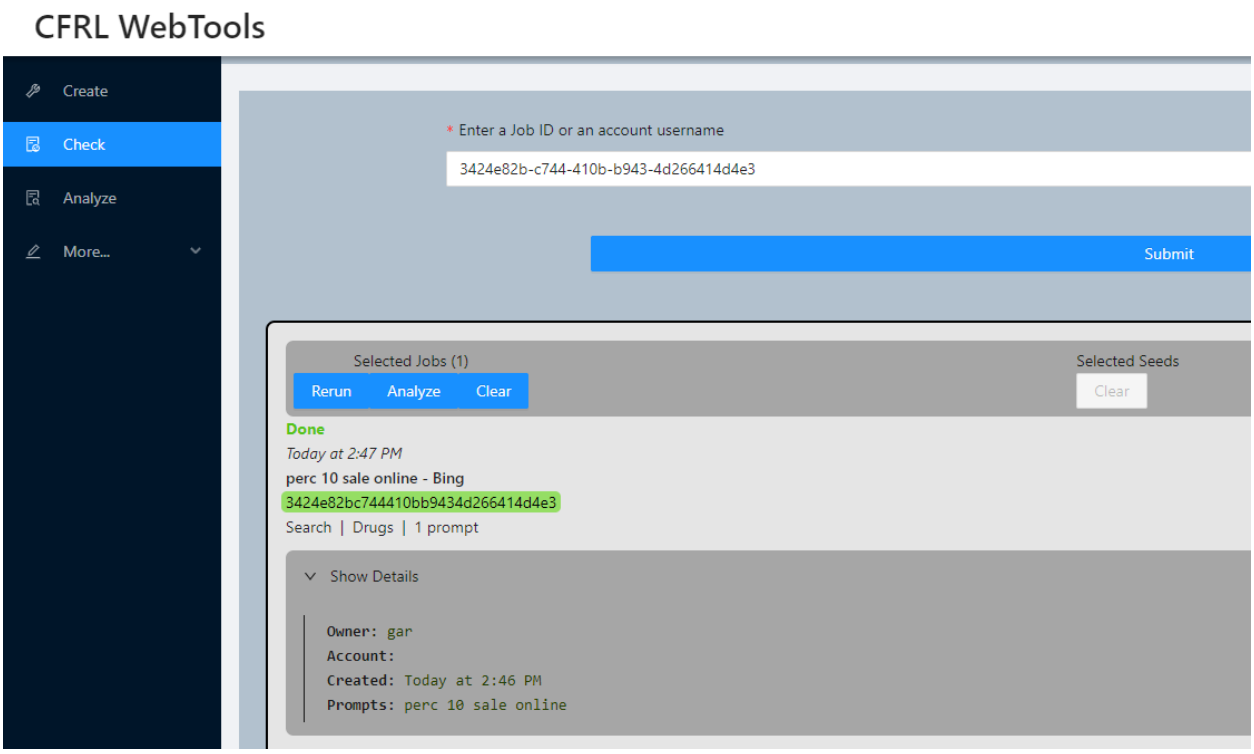

Figure 3 - job complete

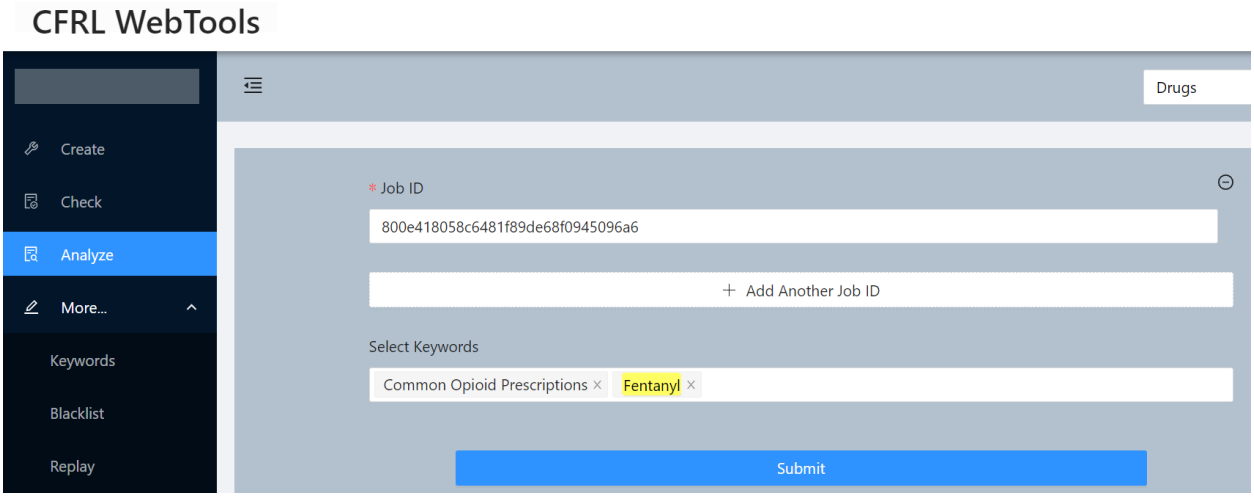

Figure 4 Selecting keyword sets for analysis

Each keyword set can be edited at any time to add additional keywords. New keyword sets can also be created and previous jobs re-evaluated by scanning the previously fetched websites with the new keyword sets.

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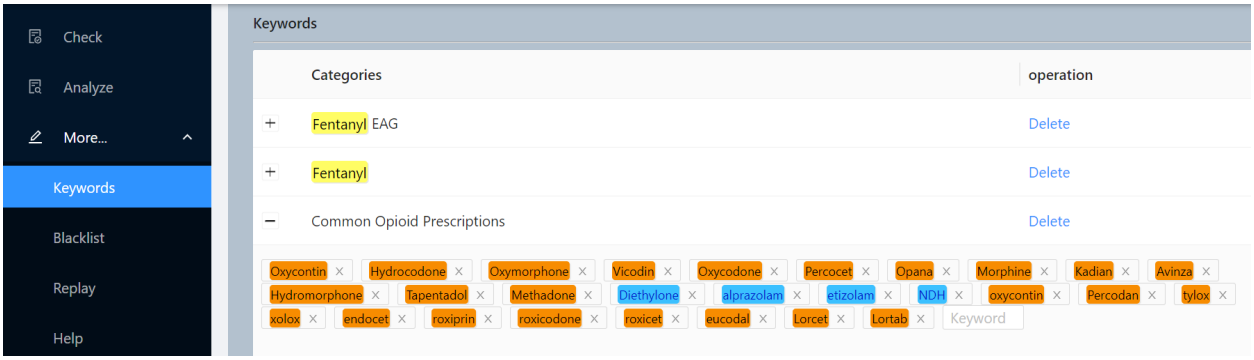

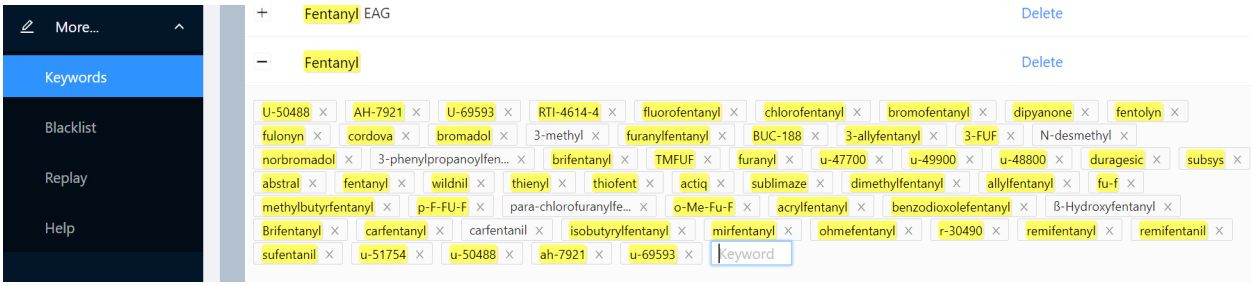

		29	4	6	16	6	236	31	2	502	11	7	12	31
domain	total	Hydrocodone	Lortab	Methadone	Morphine	Opana	Oxycodone	Oxycontin	Oxymorphone	Percocet	Vicodin	alprazolam	endocet	oxycontin
bu[redacted].com	161	10	0	0	0	0	142	0	0	4	0	2	0	0
tru[redacted]com	140	3	2	1	0	0	15	9	0	92	0	0	6	9
pai[redacted]om	140	3	2	1	0	0	15	9	0	92	0	0	6	9
bul[redacted]m	75	1	0	2	1	2	8	6	0	45	2	0	0	6
ger[redacted]	67	0	0	0	0	1	8	1	0	51	0	3	0	1
pha[redacted]owders.com	59	1	0	0	1	1	5	0	0	49	0	0	0	0
nev[redacted]m	52	5	0	0	3	0	2	4	0	27	4	0	0	4
che[redacted]24x7.com	48	3	0	0	1	0	6	1	0	31	4	0	0	1
key[redacted]acy.com	45	0	0	1	0	1	0	0	1	41	0	0	0	0
hea[redacted]nacy.com	41	0	0	1	1	1	15	0	1	21	0	0	0	0
sec[redacted]tore.com	28	0	0	0	2	0	8	0	0	18	0	0	0	0
me[redacted]cystore.com	18	1	0	0	0	0	1	0	0	15	1	0	0	0
gre[redacted]sarystore.com	18	1	0	0	2	0	6	1	0	4	0	2	0	1
alp[redacted]com	17	0	0	0	0	0	5	0	0	12	0	0	0	0
cer[redacted]online.com	7	1	0	0	5	0	0	0	0	0	0	0	0	0

Figure 5 - keyword analysis results

Search Crawler Key Word Analysis: Lists of keys words are entered and saved to be used in analysis.

When the search is completed, the results are analyzed for the presence of relevant keywords. Within the tool, results can be sorted by the number of total keyword matches the site produced. When downloaded, the number of occurrences of each keyword within the set is also indicated, allowing easy sorting or selection for specific keywords. URLs which contained keywords from the analyst set are reviewed to confirm they offer opioids for sale and are not legitimate pharmacy websites. Those which fit the criteria are added to the Opioids Master Spreadsheet. Irrelevant URLs, such as those from journals, government websites, or media websites, are added to the blacklist to be ignored in future searches.

After URLs have been added to the Opioids Master Spreadsheet, the URLs are automatically

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updated each week to determine if they are still 'live.' The date they went live, the date they go down, and the date they reappear are documented. Duplicate IP addresses and Autonomous System Numbers (ASNs) are automatically highlighted in red, making duplicates easily discernable.

The following public and commercials tools were useful when searching for websites offering opioids for illicit opioids for sale.

Highlight This is a Google add-on that can be used on both Google Chrome and FireFox to highlight lists of keywords. The lists can be color coded as shown in Figure 6.

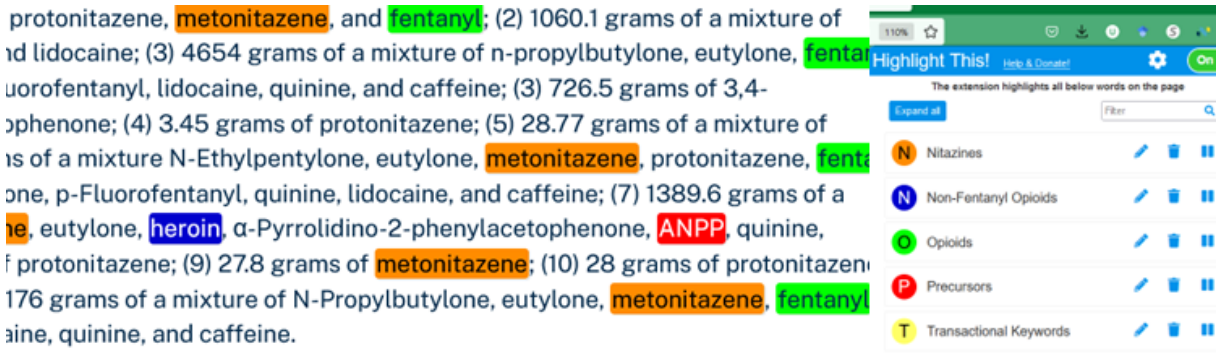

Figure 6. Highlighted keywords on web page from Highlight This Add-on on the right.

ZoneCruncher, by Zetalytics. ZoneCruncher is a commercially available Passive DNS system that has recorded the IP address and much additional information about websites on the Internet. This allows analysts to obtain lists of all other websites that share the same IP address as a target website using a technique called Reverse IP address clustering. Often this reveals many additional website addresses that are on the same host IP address and that also are associated with the illicit sale of opioids. The tool also provides information related to where and when the domain was registered, as well as where the website is hosted both geographically and on what IP address and Autonomous System Number. This information allows analysts to determine which Registrars and which hosting providers seem to be preferred by the operators of illicit drug sales web sites.

Image Searches: To do an image search with Google.com, go to Images.google.com and click on the camera icon. An image, file, or URL can be pasted into the search field. Because many websites share a common catalog of products for sale, image searches are a powerful tool for identifying additional similar websites. It has also been determined that many keywords are filtered by popular search engines, causing resultant websites to be removed prior to showing the websites to the search engine user. No such filtering seems to be in place for image matching on any of the primary search engines used in this research.

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Site Search: Used to search a specific company. The format is *site: domain keywords*, for example, site: uab.edu forensic science. This technique was often successful when searching social media platforms that were suppressing drug-related searches in their embedded on-platform search interface.

The project underwent IRB review and was designated as Not Human Subjects Research under 28CFR Part 46.102(f), pre-2018 Common Rule.

Expected Applicability of the Research

The methods developed by this research can be used to identify websites offering illicit drugs for sale by law enforcement, commercial web businesses, and researchers. The methods can be applied to most illicit online goods and services.

Participants and Other Collaborating Organizations

Elizabeth Gardner participated as the principal investigator, contributing project design and implementation, and managing the forensic chemistry graduate assistants. She has a PhD in Chemistry from Michigan State University. She has been the PI on one additional NIJ grant and is a co-PI on a second. She is currently a professor in the J. Frank Barefield, Jr. Department of Criminal Justice. She has been the program director of the UAB Forensic Science Program since 2014, having joined the department in 2007 as an assistant professor

Gary Warner participated as a co-PI and contributed to project design and implementation as well as managing the digital forensic graduate assistants. Mr. Gary Warner has 27 years of experience in the area of computer security and has been involved in investigating cybercrime, and especially email-based threats, since 2000. Since 2004, he has been involved in spam-research focused on threats to online banking, working since that time as a member of the FBI Cybercrime Task Force. He joined UAB in 2007 and started the UAB Computer Forensics Research Laboratory where 25 researchers focus their efforts on internet-based crimes, including spam, phishing, and malware

The following graduate students also worked on the project, collecting data, analyzing, and interpreting results:

Ashlyn Schultz, Transfer, Digital Forensics 2020
Amanda Cetnarowski, MS Forensic Science 2021
Qiana Staton-Vega, MS Forensic Science 2021
William Lancaster, MS Digital Forensics 2021
Sarah Jolly, MS Forensic Science 2021
Clarence Tillery, MS Cyber Security 2022
Cameron Wood, MS Computer Science 2022
Kylie Wilder, MS Forensic Science 2023

Juliann Stiny, MS Forensic Science 2023
Sydni Smith, MS Forensic Science expected 2024
Nyshae Haynes, MS Forensic Science expected 2024

Outcomes

Activities and Accomplishments

One effective technique developed for this project "Visual Keyword Cueing." As terms are identified as being related to Fentanyl or Opioids, they are added to a keyword list which causes those terms to be highlighted when observed in the analyst's browser. Because "R-30490," "MAF," and "U47700" are all categorized as Fentanyl keywords in the Visual Keyword Cueing system, even a non-chemically trained analyst can immediately recognize that the second item above is offering Fentanyl for sale.

A search-automation system was originally developed under the name *BingMagic* under contract with the ICE CyberCrime Center in Fairfax, Virginia. BingMagic was developed to optimize the identification of new drug sales sites indexed in Bing. The *Search Crawler* version of *BingMagic* created for this project has been upgraded for automating searches on three search engines; Bing, Google, and DuckDuckGo. The tool automates keyword searches and collects the selected number of URLs from the search results. *Search Crawler* uses the Microsoft-published search engine Automated Program Interface (API) to query the search engine for a combination of "drug" keywords and "sales/shipping" keywords. It attempts to open the site and the URLs of accessible sites are saved as a job. T he search can be limited to terms in the URL or the entire web pages can be searched for the keyword terms.

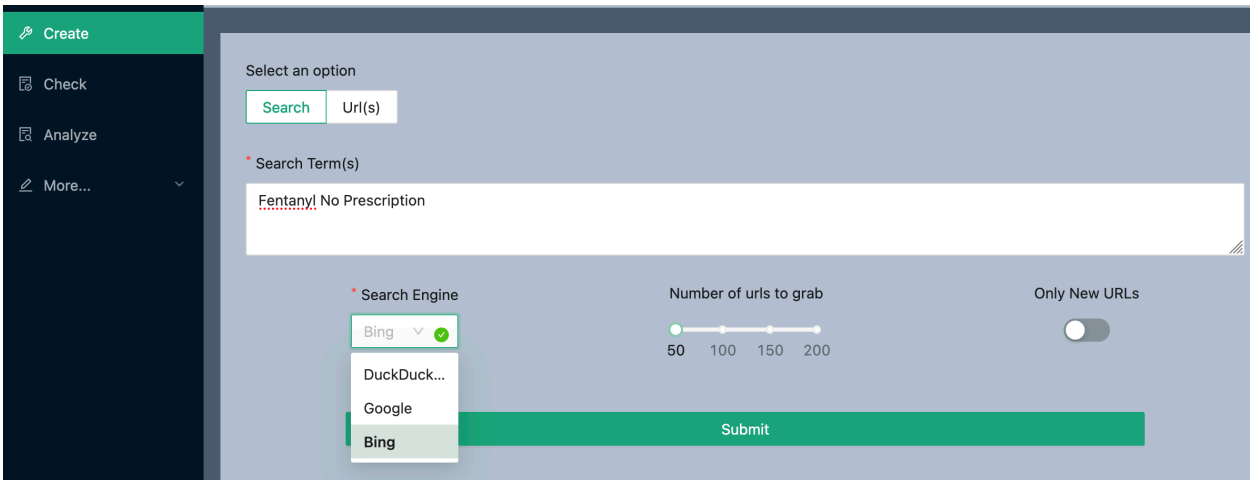

Figure 7. Entering a search using the search term combination 'fentanyl' and No Prescription', returning 50 URLs from Bing, only new URLs

Some URLs and domains retrieved from a search are not relevant, including government web

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sites, news and journal publications, and drug abuse mediation. To mitigate this issue, legitimate sites are added to a Blacklist so they do not appear in subsequent searches. Sites offering illicit opioids for sale are added to a spreadsheet for further analysis.

Search Crawler is also equipped with web archive storage for all websites documented. This is a comprehensive feature that allows for all collected to be saved, viewed, and analyzed locally. This provides documentation for the website in the event it is later altered or deleted. All types of searches can be analyzed individually or in combination. Each website retrieved by the system is scored based on how many keywords in each category and sub-category were present on that page. Once the search was completed, the data was analyzed.

Additional features of the software include a "bulk" insert option for a URL job. This function enables the copy and paste of a list of URLs. A comprehensive form was created for keywords using CRUD (create, read, update, and delete) design. This has provided flexibility and extensibility for new keywords provided by the analysts.

An on-platform analysis was developed for the web front of *Search Crawler*. Previously, the analysis output was through excel, downloaded off the platform. This is still an option, but the main medium is now to stay on the platform and see the exact same analysis in a built-in table.

Finally, the *Search Crawler* code was refactored to ensure that future programmers could continue to edit and maintain the program

The Search Crawler is not limited to the opioids project. The tool is already being applied to many issues in criminal justice, including cybercrime, human trafficking, terrorism, and counterfeit goods.

In 2023 Reverse IP Searching was added to the tools leveraged for the project. Each address was entered into the ZoneCruncher web site. Results exceeding 5,000 URLs were not analyzed as the large number of URLs indicated a predominantly legitimate commercial hosting site. When less than 5,000 URLs were returned, the results were scanned for drug related terms, i.e. pharmacy, pharm, buy meds, drug, cocaine, Xanax, Adderall, etc. If drug terms were present, the results were downloaded. The results were analyzed and only URLs and domains for sites offering opioids were retained. A total of 142 new URLs were added.

Results and Findings

There are multiple legitimate service providers whose products are being used to promote the illegal sale of opioids: search engines which allow and potentially profit from searches for opioids; domain name registrars which register domain names designed to advertise and distribute Schedule II controlled substances; hosting companies which allow or even cater to websites selling Schedule II controlled substances; and US companies who offer "sales support" chat services where a live agent will assist you in answering questions about your Schedule II purchases. The results of this project present multiple strategies for addressing online sales of

opioids

In reality, the number of web pages dedicated to the sale of drugs is a very small percentage of the total. A small percentage, even, of pages focused on drugs abuse. Searches performed using only a drug term will result in thousands of hits that are predominantly not related to the research objective, including government pages, addiction treatment, news reports. Combining a drug term with a transaction term, such as buy, PayPal, shipping, FedEx, overnight, DHL, UPS and Bitcoin produces hits directly related to drug sales, greatly reducing the number of legitimate sites included in the returned listings. Second, a direct search for a drug of current concern may not produce a large percentage of relevant results. In the time period between 2020 and 2022, drug terms such as Adderall or oxycodone were more likely to result in links to web pages selling opioids than using terms such as heroin or fentanyl. Presumably, these terms are less likely to be flagged for removal by the hosts algorithms. At the time fentanyl was considered the greatest threat for drug overdose deaths.[7]

The next step was to visit each web page and check for obvious contact information: telephone, email, WhatsApp, Wickr, Kik, etc. For example, it was possible to connect over 23 different web businesses (URLs) through a phone number listed on the websites. Other sites will list WhatsApp, Telegram, or Wickr contact information. A website https://xmlaboX/product/fenX/[1] was found using the drug search terms "2 methyl ap 237 vendor." 2 methyl ap 237 is a novel synthetic drug with opioid agonist-like activity and 'vendor' is a transaction term that limits the hits to sites likely to be selling drugs. Then information on the site, such as their WICKR address was used to find additional information about this vendor. In this case, Blogspot comments were found to contain links to vendors selling their drugs. Two blog contained links to the same URL. However, a third directed to a new URL https://xxxlabXXXX.com/ with the same WICKR address.

After collecting URLs of sites that offer illicit opioids for sale an analysis of the data indicated the following trends.

25% of the 1,947 sites have gone down, 7.6% of those have reappeared. Previous studies of online pharmacies had shown that illicit sites survive for years without being taken down for breaking the law or for violating the terms of the service established by web apps. It was not expected that URLs would reappear after being deleted. Consequently, from this point on, live sites were tracked.

39% of websites are found using Bing, 30% with Goggle (30%) and image searches (29%) next in producing hits. No conclusions can be made about the different search engines as only new URLs are collected, so the number of websites found is dependent on the order in which the search engines are searched.

The majority of email accounts used by the vendors are custom accounts, rather than

1. All URLs are obfuscated as required for federally funded research

@yahoo, @gmail or @protonmail. @outlook accounts for less than 1%. This does indicate some effort at disguising the web owner's identity.

Namecheap is the most common web host at 35%, followed by Shinju (17%) and NameSilo (16%).

80% of the sites accept bitcoin and the next most prevalent payment method is Western Union at 55%. The total is more than 100%, as most sites honor more than one payment method.

67% of the sites are in the ARIN registry, 24.5% in Ripe ncc, and 7.4% in Apnic.

Following this analysis, a script was written to check if sites were still active, even the URLs for sites previously determined to be down. A table tracking the number of sites found for each 6-month period is shown below

Table 1. URLs of Commercial Websites Selling Illicit Opioids.

Collection during previous 6 months	New Sites	Collection Focus	Total Sites	Total Active Sites
June 30, 2020	848	Search Engines. 55 Social Media Profiles with 12, 918 followers	848	Not determined
Dec. 31, 2020	1,099	880 Facebook pages, 563 Twitter pages with 168,550 followers, likes, and reposts	1,947	Not determined
June 30, 2021	62		2009	
	Sites Found		Total Sites	Total Active Sites
Dec. 31, 2021	360	893 Facebook, 589 Twitter, and 55 Instagram with 416,061 followers, likes, and reposts	2,369	1,326
June 30, 2022	355		1,732*	1,264
Dec. 31, 2022	203		1,935	824
June 30, 2023	413		2,348	1,026
Dec. 31, 2023	210		2,558	1236

- *Removed B2B URLs

Persistence

A common misconception is that sites selling illicit drugs are short-lived, being quickly shut down. To examine the longevity of sites, a random sample of 422 sites collected over two years was selected for the data analysis of persistence of illicit drug sites. Of the 422 sites, 101 sites

were down, 4 sites had been seized by the DEA, 50 sites had some sort of complication, and 7 sites no longer sold opioids. Of the remaining 260 sites that remained live, the sites were searched for opioid sales. In total, 171 different opioids/ precursors were being sold, including 20 prescription opioids, 139 research chemicals, 80 fentanyl analogs, 2 precursors fentanyl, 4 that could not be correlated to a structure, 1 non-synthetic opioid, 2 opioid blends, and 1 active metabolite. The top 20 drugs and the number of sites they appeared on are shown in Table 1. Of these, 13 were prescription drugs, 6 were research chemicals, and 4 were fentanyl analogs.

Table 2. Top 20 Opioids Sold on Persistant Websites.

Drug	# of Sites
Oxycodone	179
Hydrocodone	148
Tramadol	137
Fentanyl	120
Buprenorphine	105
Codeine	105
Methadone	100
Hydromorphone	96
Morphine	86
Oxymorphone	79
Heroin	53
Meperidine	45
Carfentanil	45
U-47700	44
Tapentadol	34
Furanyl Fentanyl	33
Acetyl Fentanyl	32
ButyrylFentanyl	25
O-DMST	19
U-48800	17

The search terms used in identifying the first 400 web pages identified in 2020 were used again to determine if the two-year-old terms would still produce results. The 400 sites had been found using 38 different key word combinations. Using the Google search engine, a total of 164 opioid sites were identified, of which 41% were new sites and the remaining were sites that were still active two years after first being documented. Six of these terms did not produce any illicit opioid pages and eight did not result in any new sites being identified but did result in previously documented sites. This would indicate that the keywords change rapidly.

Table 3. Terms that still resulted in new web sites in 2022.

Term	# of new of hits
buy oxy online bitcoin	30
buy research chem no rx	24
buy carfentanil	24
buy carfentinil online	21
buy fentanyl	21

Searches were performed on the three most popular search engines using the search terms, buy opana, buy carfentanil, buy oxy online bitcoin, oxycodone, and buy fentanyl. The first five pages of hits were analyzed in order to evaluate how effectively each search engine was in blocking sites involved in the sale of illicit opioids.

Table 4: Totals for Search Engines A, B, and C by Category

Category	Abbr.	A	B	C	total
Business to Business	**B2B**	**6**	**16**	**12**	**34**
Government Info	GI	73	17	17	107
Harmful Info	HI	9	9	10	28
Harm Reduction	HR	21	8	8	37
Illicit Source	**IS**	**9**	**101**	**95**	**205**
Legitimate Info	LI	78	48	66	192
Legitimate Source	LS	24	11	8	43
News Source	NS	44	37	31	112
Social Media	SM	1	9	4	13
User Generated Content	UGC	**16**	**22**	**26**	**64**
Unrelated/Unreachable	UR	20	41	43	104
		301	319	320	

The sites were organized into 12 categories: legitimate information (LI), harm reduction (HR), government information (GI), legitimate source (LS), illicit source (IS), news source (NS), social media (SM), user generated content (UGC), business to business (B2B), harmful information (HI), unreachable, or unrelated (UR).

Search engine A provided the fewest IS links with a total of nine. Search engine B provided the most IS links with 101 including promoted links. Search engine C had 95 IS links. Search engine A also provided the fewest BB links with a total of six. Search engine B provided the most BB links with 16. Search engine C had 12 BB links. Search engine A and search engine B each provided 9 HI links. Search engine C had 10 HI links. The team also identified 64 links to pages that are not related to the opioid trade but allow for user generated content. In the case of these links, users provided information that indicates illicit drug trade including product

information, and links or contact information to purchase opioids. Search engine A produced 18 such links, search engine B produced 23 links and search engine C yielded the most links with 26.

The B2B and UGC were not included as illicit sites as they are indirect routes to the actual site selling opioids.

Additional Findings

Previously, we had noted that many sites that had become inactive would reappear after several months. An analysis of randomly selected 300 currently inactive sites showed that 27 (9%) had been reactivated, although only 8 of these were still selling opioids. Less than 5% resulted in redirection to new domain and six of the sites were renamed, but still selling opioids. Some reactivated sites had transitioned to other products, including scrubs, wine, fake passports and licenses, and ceramics.

A tactic that is becoming more common on social media is to fake well known legitimate markets. Examples include a fake Facebook page imitating a Walgreens Pharmacy. Other sites mimicked well known pharmaceutical manufacturers, such as Purdue Pharma and Cayman Chemical.

Even internet map services are being used to promote links to URLs selling illicit opioids. Some of these sites have been visited over 4,000 times. This is unusual, few of the UGC links have more than 100 like or visits. The site being advertised below has been viewed over 14,000 times. The implications of this UGC are currently being investigated.

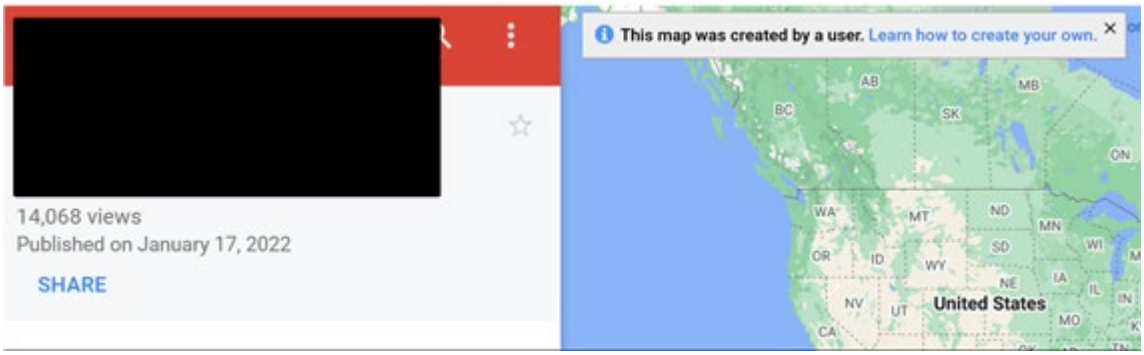

Figure 8. Figure 4. Google Maps UGC advertising a web site that sells oxycontin.

An internet source was identified that is selling physician's personal information and DEA registration numbers.

Current Trends

While academic researchers find illicit web sites through search engines, it does not appear to be

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how an individual interested in buying opioids finds the sites. If the websites are not being found through an internet search, they could be accessed by typing in the URL, or more likely, they are accessed by clicking on a link on another web page. But how are they being found? Increasingly, the answer lies in the category of internet information, user generated content (UGC).

User generated content is increasingly being used to promote the sale of illicit drugs through legitimate online businesses. By using well-established legitimate domains these illicit vendors gain much higher ratings in search algorithms and are not filtered by institutional or parental firewall filters. By using a trusted sites, a vendor can be seen in say a high school, where normally the domain would be filtered and unreachable.

User-generated content (UGC) is any content uploaded by users onto social cataloging company or a business-oriented social networking company, including text, images, videos, reviews, reviews, original content, and testimonials. An example might be a print on demand company that sells artwork uploaded by customers. The UGC in this case includes the artwork uploaded by the artist, comments on the art, and reviews of the artist's work. The 'artwork' may simply be an image and the name of the picture is a link to a website. Additional information can be uploaded to the product description and comments sections. The listing can be 'liked', making it more likely to appear in searches. The UGC is also less likely to be monitored and removed for content.

A review of the most successful key words tested in 2023 found that combinations targeting User Generated Content (UGC) are currently in the top ten most productive search term combinations. Company names have been replaced with XXX. These are legitimate companies, some global, that offer products from music to career services. At least one of these companies has federal agencies in their customer list.

1. Buy oxy no rx
2. buy oxy no script
3. buy 4-ANPP
4. morphine no prescription
5. **site: XXX.com oxycodone**
6. **site: XXX.com Adderall**
7. **site: XXX.com buyadderallpillsonline**
8. **Site: XXX.com buy Xanax**
9. order oxycodone (image search)
10. buy meperidine (image search)

Examples of UGC that provides information and links to purchase opioids can be found in nearly every type of internet business, including recipe collections, lists, online course management systems for k-12 and universities, music, cloud services, book reviews, online professional networks, online magazines, news services, online presentation sharing services, computer sales,

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scam alert sites, and online product development sites. Many of the sites are for nationally recognized companies with a high level of public trust. Generally, UGC was found through a search engine.

At stated previously, searching Adderall or Tramadol will often produce results for pages selling opioids, where the term *Buy Fentanyl* will not. It is possible that references to fentanyl will be flagged for removal, whereas the less hazardous drugs are overlooked. For example, a search of the term, *Buy Adderall*, resulted in a link to an online professional network. A search of the site using the same term resulted in 39 pages of hits. The majority of the sites in the 39 pages contained links to a URL for a webpage selling drugs. The site search function provided the capability to refine the results based on business accounts containing the search term, which returned 245 businesses with the term, *Buy Adderall* in their business name. Businesses with a paid membership are promoted by the network. Many of the hits were for promoted businesses paying for this service, indicating the URL led to a site actively involved in the sale of opioids.

There is also UGC advertising illicit drugs on an internet business that provide reviews of companies, including banks, car dealers, real estate agents, electrical companies, and pet stores. Another is a site designed to train and promote novice podcasters owned by a national radio company. Drug associated UGC seems to have infiltrated nearly every online platform.

Several things have become apparent as more UGC was found through internet searches. Illicit drug related UGC is appearing in web sites of high-profile businesses. Consequently, these listings are not being flagged by the search engine algorithms designed to block illicit sites. It also serves to promote the site through search engine optimization, increasing visibility. The sites being identified are significant, as paid accounts are being used to promote the links.

The same URLs were being promoted over many different company websites. Again, maximizing the number of sites containing a URL is a factor in search engine optimization. There are several services available for spamming ads on commercial sites. Examples are Xrumer which will spam an ad on thousands of sites, XEvil which can solve all types of captchas and post even if captcha solving is required, and SocPlugin which spams links on Facebook and VKontakte pages

Many URLs contained identical information, such as phone numbers or addresses, even though the names of the businesses were different. It is likely that these sites are part of an affiliate program, a larger organization that offers templates for webpages designed to sell opioids and pays a commission for any subsequent sales.

Limitations

No attempt was made to verify if the sites advertising illicit opioids actually ship a product or if it is simply a scam to steal money.

ARTIFACTS

List of Products

Search Crawler, an automated web search tool that will collect and rate URLs relative to an entered list of key words. Features include blacklisting irrelevant web sites and capturing the collected sites so the information is still available if the site is deleted or taken down.

Data Sets Generated

Sites Selling Illicit Opioids data

B2B Opioid Sales

Dissemination Activities

Publications

Gardner EA, Warner G, Tillery T, Jolly J, and Staton-Vega Q, "The US Opioid Crisis: 2021 Update" The IACFT Gazette, 1(1) 2023.

The opioid crisis: Prevalence and markets of opioids; Gardner EA, McGrath SA, Dowling G, Bai D; 34(1):43–70; 2022.

Oral Presentations

Opioids: What you can't buy, can't kill you, Elizabeth Gardner* and Gary Smith. University of Alabama at Birmingham Institute for Human Rights, April 17, 2023, Birmingham, AL

Gardner EA, Warner G, Illicit Fentanyl Markets on Clearnet Websites, Academy of Criminal Justice Sciences 2023, National Harbor MD, March 14-18, 2023

Posters

Opioids: What You Can't Buy, Can't Kill You. Sydni Smith*, Gary Warner, Clarence Tillery, Juliann Stiny, Kylie Wilder, Cameron Wood, and Dr. Elizabeth Gardner. Alabama State Association of Forensic Sciences, May 31, 2023, Gulf Shores, Alabama.

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