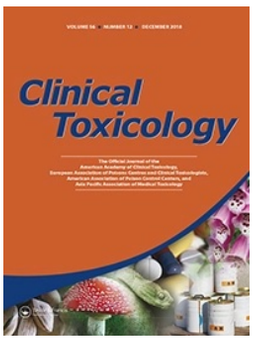

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POISON CENTRE RESEARCH

Prime eligible poisons: identification of extremely hazardous substances available on Amazon.com®

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ABSTRACT

Background: Widespread use of the Internet has increased availability of numerous products. Multiple published cases highlight that toxic xenobiotics are available for purchase online. Most cases describe purchase from the deep web. We sought to identify extremely hazardous substances available from an online retailer.

Methods: Over a 10-month period, the online retailer Amazon.com® was searched for each of the products listed by the Environmental Protection Agency's "List of Extremely Hazardous Substances." Product names, availability on Amazon Prime®, need for a business account, price, and quantity were collated.

Results: We identified 79/340 (23.2%) of these substances were available on Amazon.com®. Almost one-third of the available substances were eligible for Amazon Prime®. Approximately one-third of the products were available in an amount that could be toxic by purchasing a single unit (31/79). Of these 31 products, only four required a business account, 18 were eligible for Amazon Prime®, and nine were neither eligible for Prime nor required a business account. Notable products include sodium azide, acrylamide, mercuric acetate, and hydrazine.

Conclusions: The ease of purchase and ready availability of such highly toxic substances is concerning. Online retailers like Amazon.com® should consult with toxicologists or other qualified experts and governmental agencies to identify which products should be removed or restricted to business accounts.

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Internet; poisoning; extremely toxic

Introduction

Widespread use of the Internet and online marketplaces has increased availability of numerous products by bringing together sellers and consumers. Published literature suggests that many pharmaceutical and nonpharmaceutical xenobiotics can be readily purchased online, including: phenibut [1], ibogaine [2], oil of wormwood [3], ricin [4], sodium azide [5], *Cerbera odollam* seeds [6], and cyanide [7]. Many of these cases previously involved purchases via cryptomarkets on the darknet, a component of the deep web often associated with nefarious activities [7,8]. These cryptomarkets often facilitate illegal drug trade utilizing virtual money (aka. bitcoin), whereas other sites on the "surface web" use local currency or United States Dollars [7]. Alarmingly, in 2005, Cantrell described the availability of 121 poisonous products on the "surface web" online marketplace, eBay® [9]. Sparked by a recent fatal case of sodium azide toxicity from a product purchased online [10], we sought to identify the availability of toxic xenobiotics from a commonly used online retailer.

Methods

A single author reviewed toxic products available on Amazon.com® using the "List of Extremely Hazardous Substances" defined by the Environmental Protection Agency (EPA) [11]. This list is established by the EPA to identify chemical substances that could cause serious irreversible health effects from accidental releases; initially published in 1986 and updated in 2006. Each product was searched for on Amazon.com® between March 2018 and December 2018. Amazon.com® is an international online retailer. Amazon Prime® is a paid subscription service of Amazon® that includes free two-day shipping, one-day shipping, and for some products and regions, same-day shipping. A Microsoft Excel spreadsheet was generated to include the product name, availability on Amazon.com®, eligibility for Amazon Prime®, whether purchase was limited to a business account, the price, and quantity available. When available, relative toxicity was recorded on a scale of 1–6 according to Gosselin's Clinical Toxicology of Commercial Products where a rating of 1 is essentially nontoxic with an estimated lethal dose of greater than 15 g/kg and 6 is "supertoxic" with a probable lethal oral dose of less than 5 mg/kg [12]. When toxicity ratings were not available from Gosselin's, the Immediately Dangerous to Life or Health (IDLH) from the National Institute for Occupational Safety and Health or the Lethal Dose in 50% of subjects available from the National Library of Health's Hazardous Substances Data Bank was recorded

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[13,14]. The practical toxicity of quantities available was determined by the authors based on quantity available in a single unit purchase and the inherent toxicity of the agent according to Gosselin's. Products with only an animal LD_{50} listed were noted as "unknown" toxic potential due to limited human data. The institutional review board at our institution reviewed this study and determined it to be non human subject research.

Results

The List of Extremely Hazardous Substances contains 340 substances. A total of 79/340 (23.2%) of these substances were available on Amazon.com®. Almost one-third of the available substances, 24/340 (7.1%), were eligible for Amazon Prime® and only 17 (5.0%) required a business account. The average price of products was $61.20 (Standard Deviation: 75.32) with a range of $7.02–$346.40. Approximately one-third of the products were available in an amount that was considered toxic with a single-unit purchase (31/79). Of these 31 products, only four required a business account, 18 were eligible for Amazon Prime®, and nine were neither eligible for Prime nor required a business account. Table 1 lists the products available, including Prime® eligibility or need for a business account, quantity available, and relative toxicity.

Discussion

We identified greater than 20% of chemicals included on the EPA List of Extremely Hazardous Substances available for online purchase on Amazon.com®. The availability for purchase of these highly toxic substances has implications for public health. Cases of cyanide poisoning resulting in severe illness [15] and death [16] and sodium azide resulting in death [10] have already occurred due to products purchased from online retailers including Amazon.com®.

Individual case reports discuss purchase of pharmaceuticals and nonpharmaceutical products for self-harm primarily via the darknet [1–8]. It is concerning that these products are available via the internet at all, but the need for virtual currency or specialized software to browse the darknet provide at least some barriers to access [17]. Such barriers may limit access from younger patients or those who do not have access to this Internet content or cybercurrency. Unfortunately, as demonstrated in our case and others, as products become available on a marketplace such as Amazon.com® the barriers to access are far simpler to overcome [15,16], including only a shipping address and credit card.

With over 100 million Amazon Prime® members [18] and Prime® delivery often offered within 48 h of order, extremely toxic substances can be rapidly delivered to consumers. Furthermore, packaging is commonly seen and would not be suspect. Such large market share and potential for rapid and nondescript delivery provides potential for harm. Our study differs from Cantrell's in that eBay® is an open marketplace that allows exchanges person to person [9]. Alternatively, many of the products available from Amazon.com® are fulfilled by Amazon, rather than directly from sellers/suppliers. These products are stored in Amazon warehouses and shipped from the warehouse after purchase. Amazon requires sellers to provide information about dangerous goods, but clearly does not completely restrict the sale, or would prevent the product from being listed completely [19,20]. Both websites prevent sales of some items, but this clearly does not preclude purchase of highly toxic substances.

Limitations

Some limitations should be noted. We used the EPA's List of Extremely Hazardous Substances to determine our search criteria on Amazon.com. This means we did not search for or include other substances (e.g., laetrile, antimony potassium tartrate). While the list of Extremely Hazardous Substances was not established to identify all or only acutely toxic chemical substances, we used it because it is a readily available list of products known to be hazardous. We provided relative toxicities according to Gosselin's [12] or established government resources. Gosselin's provides estimates of mortality and not morbidity, so when available, we estimated the practicality of acquiring a fatal dose. Only about one-third of the products were readily available in a fatal dose. Additionally, we searched only on Amazon.com rather than other sites, which sell products like amygdalin tablets [21]. We believe that this structured search provided a thorough evaluation and adequately presents the issue that potent toxins are readily available. Due to a lack of funding, we did not purchase any of the products. The process involved in adding the products to the cart and progressing to "place your order" was similar to other purchases we have made on Amazon.com®. Amazon does restrict product listing for some hazardous items, but clearly not all extremely hazardous products are included. It is possible that restrictions occur after the order is placed, but the history in the case that sparked this study suggests any current restrictions are inadequate. Finally, our study was performed over a short period of time and availability of these products may vary with some periodically unavailable. Regardless, the fact that they were available at any time is concerning. We would argue that availability for a single day resulting in purchase and a potentially preventable death is just as important as indefinite availability.

Conclusion

The ease of purchase of highly toxic substances via a frequently used online retailer is concerning. Our goal is not to recommend that all potentially toxic substances be removed from Amazon.com®. Instead, we recommend that online retailers like Amazon.com® consult with toxicologists or other qualified experts and governmental agencies to identify which products should be restricted to purchase by verified business accounts or have other barriers put in place.

Table 1. Products from the EPA extremely hazardous substances list were available for purchase from Amazon.com®, availability via Amazon Prime®, need for a business account, the quantity available, and toxicity of the product.

Product	Prime or Business	Quantity available	Relative toxicity [12–14]
2-chloroethanol		1 mg	5
Acrylamide	Prime	100 g	4
Adiponitrile		1 mg	LD_{50}: 155 mg/kg (rat)
Aldicarb		1 mg	6
Aldrin		1 mg	5
Allyl alcohol		1 mg	3
Allylamine		500 g	LD_{50}: 106 mg/kg (rat)
Ammonia	Prime	500 g	300 ppm (ILDH); LD_{50}: 350 mg/kg (rat); caustic*
Aniline		100 mL	4
Azinphos-ethyl		1 mg	LD_{50}: 7 mg/kg (rat)
Azinphos-methyl		1 mg	5
Benzyl chloride	Prime	2.5 L	10 ppm (IDLH); LD_{50}: 440 mg/kg (rat)
Boron trichloride		1 mg	caustic*
Boron trifluoride		1 mg	25 ppm (IDLH)
Bromadiolone	Prime	22.7 mg	LD_{50}: 0.56–0.84 mg/kg (rat)
Cadmium oxide	Prime	500 g	5
Carbofuran		1 mg	5
Carbon disulfide		1 mg	3
Carbophenothion		1 mg	"Highly"**
Chlorfenvinfos		5 mg	LD_{50}: 9.66 mg/kg (rat)
Chlorine	Prime	5 Lb (90% Chlorine)	10 ppm (IDLH); caustic*
Chlormequat chloride		50 g	5
Chloroacetic acid	Prime	500 g	4
Chloromethyl ether		1 mg	LD_{50}: 210 mg/kg (rat)
Chloromethyl methyl ether		1 mg	LD_{50}: 500 mg/kg (rat)
Chloroxuron		1 mg	3
Chlorthiophos		1 mg	LD_{50}: 9.1 mg/kg (rat)
Chromic chloride	Prime	500 g	25 mg/mg^3 (IDLH); LD_{50}: 1870 mg/kg (rat)
Colchicine	Business	5 g	6
Coumaphos		1 mg	4
Cresol, -o	Business	4 L (99.2%)	4
Crotonaldehyde		1 mg	5
Cyanogen bromide		1 mg	LD_{50}: 25–50 mg/kg (rat)
Cyanophos		1 mg	LD_{50}: 710–730 mg/kg (rat)
Cycloheximide		5 g	5
Cyclohexylamine		120 mL	4
Demeton		1 mg	5
Dichlorvos		1 mg	4
Dicrotophos		1 mg	5
Diglycidyl ether	Business	25 g	3
Dimefox	Business	1 mg	5
Dimethoate		3944 kg	4
Dimethylhydrazine	Business	1 mg	5
Dinoseb	Business	1 mg	5
Dioxathion	Business	1 mg	4
Diphacinone	Business	22.7 mg	5
Endosulfan	Business	1 mg	4
Endrin	Business	1 mg	5
Epichlorohydrin	Business	25 g	4
Ergocalciferol	Prime	6 million U	–
Formaldehyde		1400 g	3
Hydrazine	Prime	100 g	5
Hydrogen peroxide (32%)		3.79 kg	75 ppm (IDLH); Caustic*
Hydroquinone		250 g	4
Lithium hydride		25 g	500 mg/m^3 (IDLH); Caustic*
Mercuric acetate	Prime	100 g	***
Mercuric chloride	Prime	100 g	6
Mercuric oxide	Prime	100 g	***
Nitrobenzene	Prime	500 g	5
Paris green		454 g	5
Phenol	Prime	50 g	4
Phenylthiourea	Prime	100 g	5
Pyrene	Prime	5 g	LD_{50}: 2700 mg/kg (rat)
Semicarbazide hydrochloride	Business	25 g	LD_{50}: 225 mg/kg (mouse)
Sodium arsenate	Business	250 g	5
Sodium azide	Prime	100 g	6
Sodium cacodylate		500 mL	4
Sodium pentachlorophenate	Prime	500 g	4
Sodium selenate	Prime	100 g	6
Sodium selenite	Prime	100 g	6
Sulfuric acid	Prime	1M 1 L	LD_{50}: 15 mg/m^3 (IDLH); caustic*
Tellurium		10 g	5
Thiosemicarbazide		25 g	LD_{50}: 9.16–13 mg/kg (rat)

(*continued*)

Table 1. Continued.

Product	Prime or Business	Quantity available	Relative toxicity [12–14]
Toluene 2,6-diisocyanate	Business	1 g	2
Trichloronate	Business	1 mg	LD_{50}: 16–50 mg/kg (rat)
Trimethylolpropane phosphite	Business	5 g	"Extremely"^
Triphenyltin chloride	Business	5 g	4
Warfarin	Prime	455 mg	4
Zinc phosphide	Prime	9080 mg	5

Toxicity ratings according to Gosselin's (estimated lethal oral dose): 1, >15 g/kg; 2, 5–15 g/kg; 3, 0.5–5 g/kg; 4, 50–500 mg/kg; 5, 5–50 mg/kg; 6, <5 mg/kg.
IDLH: Immediately Dangerous To Life or Health; provided by National Institute of Occupational Safety and Health.
LD_{50}: lethal dose in 50% of subjects; provided by the Hazardous Substance Data Bank.
*Products in Gosselin's that are considered caustic are not given toxicity ratings because the assumption is that death will occur from secondary effects. These products are simply given the code "caustic.".
**Not given an official ranking, but Gosselin's states "highly toxic" in text.
***No data listed, but Gosselin's equates the product with mercuric chloride.
^Noted "extremely toxic" by Hazardous Substance Data Bank but no LD_{50} provided.

Disclosure statement

The authors report no actual or potential conflicts of interest.

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