Online Pharmacy Accessibility of Imatinib, An Oral Chemotherapy Medication

Yujiao Sun, PharmD1; Adam Hendrix, PharmD1; Benyam Muluneh, PharmD, BCOP, CPP2; and Sachiko Ozawa, PhD, MHS1,3

Abstract

Background: Since prices of imatinib (Gleevec) remain high, patients on oral chemotherapy are looking for alternative methods to access this life-saving medication. We assessed the accessibility of imatinib through online pharmacies and analyzed each website for medication safety, price, and marketing tactics. Methods: We searched the term “buy imatinib online” using 4 commonly used internet search engines (Google, Bing, Yahoo!, and DuckDuckGo) and screened web pages displayed in the first 10 pages. Websites were included if they were published in English, sold imatinib, were free to access, and offered shipping in the United States. Websites were classified using LegitScript’s categorization as “certified,” “unclassified,” “unapproved,” or “rogue.” We analyzed information on websites’ patient safety characteristics, marketing techniques, pricing, domain registration information, and IP addresses. Results: Of the 44 online pharmacies identified, only 3 (7%) were certified, and the remainder were classified as rogue (52%; n = 23), unapproved (30%; n = 13), or unclassified (11%; n = 5). Thirteen online pharmacies (30%; 9 rogue, 4 unclassified) sold imatinib without a prescription. Nearly one-quarter (n = 10) of online pharmacies selling imatinib did not include drug-related warnings on their websites, and nearly half (n = 21) did not limit the purchasable quantity. More than three-quarters (n = 34) of online pharmacies selling imatinib did not offer pharmacist consultations, even though nearly all websites extended offers to speak with sales associates (91%; n = 40). Most online pharmacies selling imatinib claimed price discounts (95%; n = 42), but fewer provided bulk discounts (23%; n = 10) or coupons (34%; n = 15). One-third of rogue pharmacies selling imatinib (n = 7) claimed to be registered or accredited on their websites. Conclusions: The lack of safety measures taken by illegitimate online pharmacies endangers patient safety because they allow patients to purchase imatinib without appropriate evaluation for response, drug interactions, and adverse effects. Healthcare providers need to be aware of this practice and should assure patient access to imatinib through safe and legitimate pharmacies.

J Natl Compr Canc Netw 2022;20(7):808-814
doi: 10.6004/jnccn.2022.7007

Background: Chronic myeloid leukemia (CML) accounts for 15% of all patients with leukemia in the United States.1 Tyrosine kinase inhibitors (TKIs) are first-line treatment options for CML that have transformed a once-fatal disease into a treatable chronic condition with extended life expectancy.2 Despite the clinical benefits, the cost of TKIs continues to be a significant barrier to access because most patients need to take imatinib indefinitely.3-5 Generic imatinib (Gleevec), the most widely used TKI among patients with newly diagnosed CML, became available in the United States in 2016. The advent of the generic reduced imatinib’s US retail price by 30% compared with the price of brand-name imatinib, whereas in other countries price reductions were as great as 82%.6 However, patient assistance programs from pharmaceutical manufacturers have declined in response to the availability of generics, in effect increasing out-of-pocket payments for some US patients taking generic imatinib.7 With the increase in number of online pharmacies offering imatinib, patients may turn to less legitimate websites that promise lower prices.8

Online access to treatment for CML is a significant concern if medicines are dispensed without a prescription or proper clinical oversight.8 With imatinib, contact with a medical team is critical because patients must be frequently monitored for treatment response and must receive medication adjustments as necessary.9 Imatinib requires an adherence rate greater than 85% to 90% to achieve optimal clinical outcomes.10,11 But patients with higher copayments have been found to be more likely to discontinue or be nonadherent to TKIs.12 By utilizing online pharmacies, patients miss out on the patient–provider interaction and may experience greater risks of potential treatment failures and adverse events.13

In 2016, there were 30,000 to 35,000 online pharmacies accessible in the United States.14 However, 96% of online pharmacies failed to adhere to US legal standards and therefore posed a threat to patient safety.13,14 There is currently no published evidence characterizing the availability of imatinib through online pharmacies and the regulatory compliance of these pharmacies. The ease with which imatinib may be purchased through online pharmacies...
pharmacies can pose a legitimate public health hazard. We investigated the accessibility of imatinib through online pharmacies and assessed each site with respect to medication safety, price, and marketing tactics.

**Methods**

We searched for online pharmacies selling imatinib using 4 common search engines—Google, Bing, Yahoo!, and DuckDuckGo—with the search term “buy imatinib online” between February and April 2021. Websites displayed in the first 10 pages of search results were screened for inclusion. Websites were included for analysis if they were active, were published in the English language, were free to access, claimed to sell the drugs of interest, had a unique URL, and shipped imatinib in the United States. Screenshots of included web pages were taken when pages were accessed.

Information collected from these websites included patient safety characteristics, marketing techniques, and pricing information. Patient safety characteristics included whether the online pharmacies provided information on proper administration, gave adverse event warnings, recommended imatinib use under physician guidance, required prescriptions, and offered pharmacist counseling. Marketing characteristics examined whether the websites made registration claims with pharmacy regulation bodies, assured privacy, provided coupons or promotion codes, or claimed price discounts compared with traditional pharmacies. Included websites were cross-referenced with the FDA’s list of internet pharmacy warning letters and noted whether a match was found. Descriptive statistics were used to summarize each safety and marketing characteristic.

For pricing information, we collected the reported price for all generic and brand-name formulations of imatinib from each manufacturer as provided by the websites. For online pharmacies that did not provide pricing information up front, an inquiry was sent using online forms and the websites’ quoted price was recorded. Prices for a 30-day supply of the most used imatinib 400-mg formulations were analyzed. Online pharmacy prices were compared with prices offered on GoodRx (www.goodrx.com), a prescription drug coupon site that tracks prescription drug prices in brick-and-mortar pharmacies in the United States.

The legitimacy of websites was assessed using LegitScript (www.legitscript.com), which monitors online pharmacies regarding their compliance with applicable laws and regulations. LegitScript has classified many online pharmacies as “rogue,” “unapproved,” or “certified.” Rogue classification denotes a website engaging in “illegal, unsafe, or misleading” activities, such as selling counterfeits, expired, misbranded, or falsified products; selling prescription drugs without prescription requirements; and dispensing medicines without appropriate and valid pharmacy licenses. Unapproved online pharmacies have “some problem with regulatory compliance or risk, but … are typically less egregious than ‘rogue,’” such as operating legally in one jurisdiction but not in others. Websites that were not classified in LegitScript’s database were categorized as “unclassified.” Noncertified websites were considered illegitimate for this analysis.

Country locations reported on pharmacy websites were recorded and cross-checked with registered locations of the websites’ IP addresses identified via Hosting Checker (https://hostingchecker.com), along with the domain registration locations reported by Whois (https://www.whois.com). Domain registration duration for each website was also recorded as reported by Whois. Six-month website traffic volumes were assessed using SimilarWeb (https://www.similarweb.com), which reports traffic volumes based on open exchanges of first-party data and public data sources.

**Results**

After screening 400 search results from Google, Bing, Yahoo!, and DuckDuckGo, we identified 44 online pharmacies selling imatinib to people living in the United States. LegitScript classified 3 (7%) of these online pharmacies as certified, 23 (52%) as rogue, and 13 (30%) as unapproved, and 5 (11%) were unclassified.

Website characteristics pertaining to patient safety are reported in Table 1. Remarkably, 13 (30%) websites including 39% (n=9) of the rogue websites and 80% (n=4) of the unclassified websites did not require a prescription to dispense imatinib, a prescription drug. Few websites (7%; n=3) sought background information regarding patients’ health status. Only 33% (n=1) of the certified websites, 4% (n=1) of the rogue websites, 8% (n=1) of the unapproved websites, and 0% of the unclassified websites asked patients to fill out a health-related questionnaire. The majority (77%; n=34) of websites selling imatinib failed to provide a means for patients to consult with a pharmacist. Even for certified websites, 1 in 3 pharmacies did not offer ways for patients to speak with a pharmacist regarding their medications. We found that 70% (n=16) of the rogue websites and 60% (n=3) of the unclassified websites did not impose any quantity control on how much imatinib patients were allowed to order at a time. Most websites provided some information regarding imatinib administration (75%; n=33), drug-related warnings (77%; n=34), and recommendations for patients to seek physician advice (86%; n=38). Yet, this meant 10 (23%) of online pharmacies selling imatinib did not include drug-related warnings on their websites.

Pricing for a 30-day supply of 400-mg tablets of generic and brand-name imatinib from online pharmacies was compared with the pricing at brick-and-mortar pharmacies with GoodRx coupons (Figure 1).
traditional brick-and-mortar pharmacies was USD $787.20 (range, $136.05–$9,053.91), which was more expensive compared with $296.18 (range, $165.00–$427.35) at certified online pharmacies, $234.66 (range, $28.50–$1,342.99) at rogue pharmacies, $284.69 (range, $126.00–$683.00) at unapproved pharmacies, and $115.00 (range, $65.00–$137.50) at unclassified online pharmacies. As for brand-name imatinib (Gleevec), the median price available with a GoodRx coupon was very high, at $10,513.66 (range, $9,968.87–$10,515.08) per month. In comparison, the median price for 30 tablets of Gleevec on rogue sites was $2,704.00 (range, $195.00–$4,597.99), and unapproved websites charged a median price of $2,697.50 (range, $1,682.00–$4,463.00). None of the certified or unclassified online pharmacies offered brand-name imatinib.

The marketing characteristics of online pharmacies selling imatinib are summarized in Table 2. Claiming discounted prices was a common tactic used by nearly all of these online pharmacies (95%; n=42). Coupons or promotional codes tended to be more commonly used (34%; n=15) than bulk discounts (23%; n=10). Most online pharmacies selling imatinib made an offer for customers to speak with sales associates (91%; n=40) and provided phone numbers or WhatsApp accounts (93%; n=41) for communication. Customer testimonials or blog posts on the website were most frequently used by rogue pharmacies (78%; n=18) compared with...
certified (67%; n=2), unapproved (62%; n=8), and unclassified pharmacies (40%; n=2). The majority (86%; n=38) of online pharmacies selling imatinib made privacy assurance claims.

All certified pharmacies claimed to be registered with the Better Business Bureau and with LegitScript. In addition, 2 of the 3 certified pharmacies claimed to be registered with the National Association of Boards of Pharmacy. Among illegitimate online pharmacies, the majority of unapproved pharmacies (77%; n=10) claimed to be registered by governing bodies, compared with 30% of rogue pharmacies (n=7) and 20% of unclassified pharmacies (n=1). These illegitimate online pharmacies typically claimed to be registered with the Canadian International Pharmacy Association (37%; n=15), PharmacyChecker.com (27%; n=11), the International Pharmacy Association of British Columbia (19%; n=8), or the Ontario College of Pharmacists (5%; n=2).

One website (TrustedMedStore24.com) was identified in the FDA’s internet pharmacy warning letters. In addition, 6 websites in our search included phrases or keywords in their website name similar to those on the FDA’s warning list.

Figure 2 depicts the listed country, server location, and domain registration location for each online pharmacy. The number next to each country on the right equals the total times a country was listed across all categories.

In terms of how long the website domains had been active (Figure 3), certified websites selling imatinib were more established, with domain duration ranging from 10 to 19 years (mean, 13.33 years). The duration of unapproved websites selling imatinib ranged widely from 2 to 22 years with a mean of 11.77 years. Rogue and unclassified websites were less established compared with certified and unapproved websites. The interquartile range for rogue sites’ domain duration was 3 to 9 years (mean, 7.29 years), although there were 2 outlier rogue websites selling imatinib that had been registered for 19 and 20 years. Unclassified sites had the shortest domain duration, ranging from 2 to 7 years (mean, 3.5 years).

![Location listed on the website, server location, and domain registration location for each online pharmacy.](image)

The number next to each country on the right equals the total times a country was listed across all categories.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Certified n (%)</th>
<th>Rogue n (%)</th>
<th>Unapproved n (%)</th>
<th>Unclassified n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total, n</td>
<td>3 (100)</td>
<td>23 (96)</td>
<td>13 (65)</td>
<td>5 (25)</td>
<td>44 (95)</td>
</tr>
<tr>
<td>Price discount claims</td>
<td>3 (100)</td>
<td>22 (96)</td>
<td>13 (65)</td>
<td>4 (80)</td>
<td>42 (95)</td>
</tr>
<tr>
<td>Bulk discounts</td>
<td>1 (33)</td>
<td>5 (22)</td>
<td>3 (23)</td>
<td>1 (20)</td>
<td>10 (23)</td>
</tr>
<tr>
<td>Coupon or promotional code</td>
<td>1 (33)</td>
<td>9 (39)</td>
<td>4 (31)</td>
<td>1 (20)</td>
<td>15 (34)</td>
</tr>
<tr>
<td>Phone number or WhatsApp account</td>
<td>3 (100)</td>
<td>21 (91)</td>
<td>13 (65)</td>
<td>4 (80)</td>
<td>41 (93)</td>
</tr>
<tr>
<td>Offer to speak with an associate</td>
<td>3 (100)</td>
<td>20 (87)</td>
<td>13 (65)</td>
<td>4 (80)</td>
<td>40 (91)</td>
</tr>
<tr>
<td>Registration claims</td>
<td>3 (100)</td>
<td>7 (30)</td>
<td>10 (77)</td>
<td>1 (20)</td>
<td>21 (48)</td>
</tr>
<tr>
<td>Testimonials</td>
<td>2 (67)</td>
<td>18 (78)</td>
<td>8 (62)</td>
<td>2 (40)</td>
<td>30 (68)</td>
</tr>
<tr>
<td>Privacy claims</td>
<td>3 (100)</td>
<td>23 (100)</td>
<td>11 (85)</td>
<td>1 (20)</td>
<td>38 (86)</td>
</tr>
</tbody>
</table>
Discussion

Of the 44 online pharmacies identified, we found that 52% (n=23) were classified as rogue and only 7% (n=3) were certified. Nearly one-third (30%; n=13) of online pharmacies did not require a prescription to purchase imatinib, which may lead to patients obtaining inappropriate doses, experiencing adverse events, or facing treatment failures. Patients may have difficulty discerning whether specific online pharmacies are legitimate, because both certified and illegitimate websites used similar marketing tactics by claiming price discounts, providing offers to speak with sales associates, and assuring privacy. Healthcare providers need to be aware of the prevalence of illegitimate online pharmacies and the dangers patients may face by utilizing them.

The use of online pharmacies may present a significant challenge for patients with CML on imatinib given the critical importance of adherence and dose intensity for clinical outcomes. Research has found that patients taking imatinib must achieve consistently >90% adherence or risk experiencing a relapse. This translates to only 1 or 2 missed doses a month to maintain the adherence required for efficacy, which only 74% of patients on imatinib were able to maintain in one study. Although medication adherence is affected by various factors, cost is a major barrier for many patients with cancer. A 2012 study surveying patients who purchased medication from traditional and online pharmacies found that those who obtained medications online were more likely to experience adverse events compared with patients who obtained medications from brick-and-mortar pharmacies with pharmacist supervision. For patients taking oral oncolytics, a structured workflow using a medically integrated dispensing pharmacy is considered a gold standard to ensure that patients have high-quality education, monitoring, and coordination of their care. In patients with CML, a structured, closed-loop model with intensive clinical pharmacist follow-up has been shown to improve adherence rates and clinical outcomes compared with a historical approach, where the dispensing pharmacy had no affiliation with the patient’s practice-based oncology team.

The prevalence of no prescription requirements (39% of rogue pharmacies, 80% of unclassified pharmacies) on illegitimate websites is alarming because it allows patients to purchase imatinib without undergoing evaluation and follow-up by physicians and pharmacists to check for appropriateness and safety before starting and during treatment. This lack of pharmacist involvement and health-related questionnaires to collect patients’ medical history and concurrent medications is a critical safety concern because many patients with CML may be taking several interacting medications. Given the need to dose-adjust imatinib for drug–drug interactions and organ dysfunction, taking the standard 400 mg daily amount may be life-threatening for some patients. A comprehensive review of a patient’s medications and supplements is a critical step of the therapy initiation process to avoid untoward toxicities.

Given the prohibitively high cost of cancer medications, patients with cancer and providers have been attracted to online pharmacies that promise more affordable medications. However, medications that are much cheaper may be compromised. Patients who are searching for the cheapest option possible are likely to find illegitimate pharmacies offering lower prices than legitimate sources. Because brand name imatinib (Gleevec) was not available through legitimate online pharmacies, we found that patients who searched for it online were only able to reach illegitimate websites.

There is already a precedent for counterfeit antineoplastic medications entering the United States through online pharmacies. In 2012, an FDA investigation found that the Canadian online pharmacy Canada Drugs distributed counterfeit Avastin that contained no active ingredients to clinics across the United States. The FDA issued 949 safety notifications to 932 physicians or clinics in 48 states where the counterfeit medication was likely purchased and administered to patients. Despite US prosecutions, Canada Drugs remains open today and was identified in our imatinib search. International collaboration across regulatory authorities is essential as illegitimate online pharmacies have become an increasingly global public health problem. Clinicians and regulators should prevent future incidents involving counterfeit medications from bringing harm to more patients.

Moreover, it is important for clinicians to make efforts to ensure that patients are able to access the oral...
oncolytics they prescribe and to educate patients on the risk of purchasing medications through illegitimate online pharmacies. Clinicians can learn about and become familiar with manufacturer or health system medication assistance programs and patient assistance programs such as NeedyMeds.27 Physicians should consult and collaborate with pharmacists and social workers who may assist patients with enrolling in such assistance programs to improve medication affordability.

There are numerous organizations involved in combating illegitimate internet pharmacies (see Table 3). These can serve as resources for identifying illegitimate pharmacies and educating consumers about the danger of illegitimate online pharmacies.28 Yet our research showed that illegitimate online pharmacies often inauthentically claim to be registered with accrediting organizations. It is important for patients to recognize that illegitimate online pharmacies often misuse accrediting organizations’ logos and names, and for these organizations to improve their online screening and surveillance.

Our results are comparable with those of other studies on online pharmacies indicating the high prevalence of illegitimate online websites that sell prescription medicines, have weak prescription requirements, and use aggressive marketing tactics.29–31 Although previous studies cross-referenced listed website locations with IP addresses, this analysis went a step further to examine the domain registrations of the websites and found that many domains were conspicuously hidden. Our cost analysis showed that patients seeking cost savings are likely to end up on illegitimate online pharmacy websites, which aligns with an earlier analysis of insulin sold online.30 Because imatinib is well-known to be expensive, it may be that online pharmacies are eager to attract consumers by offering greater price discounts.

There were several limitations to our study. We limited our screening to the first 10 pages of search results per search engine because of feasibility, leaving many online pharmacies undetected. However, we chose commonly used search engines for the United States and replicated the behaviors of typical consumers who would likely focus on the first few pages of the search result. We did not purchase imatinib from any of the websites and therefore do not know whether a purchase results in product delivery and cannot assess medication quality. Furthermore, we were not able to investigate the websites’ actual dispensing locations because many websites used services to conceal their domain locations. Finally, our results represent a slice in time given the transient nature of online pharmacies and search engine algorithms. Still, we hold that searches for imatinib on common search engines are relevant and important to examine the accessibility of an oral chemotherapy medication online. Despite the limitations, we followed a systematic approach to present a cross-sectional analysis to characterize the accessibility of imatinib online.

**Conclusions**
The availability of imatinib through illegitimate online pharmacies places patients at risk of experiencing toxicities and treatment failures. We found that many (30%) online pharmacies were selling imatinib without requiring a prescription and that the vast majority (93%) did not require any health-related questionnaires. Nearly one-quarter (23%) of pharmacies did not include warnings related to imatinib, and most (77%) lacked offers for pharmacist consultations. Raising public awareness and providing resources to patients will help them better identify legitimate online pharmacies. Providers should be aware of easy access to oral oncolytics online and be sure to educate and assist patients in obtaining medications through safe and legitimate sources. Furthermore, efforts by the FDA, internet service providers, credit card

### Table 3. Internet Pharmacy Resources

<table>
<thead>
<tr>
<th>Information Sources</th>
<th>Websites</th>
</tr>
</thead>
<tbody>
<tr>
<td>BeSafeRx campaign</td>
<td><a href="https://www.fda.gov/drugs/quick-tips-buying-medicines-over-internet/besaferx-your-source-online-pharmacy-information">https://www.fda.gov/drugs/quick-tips-buying-medicines-over-internet/besaferx-your-source-online-pharmacy-information</a></td>
</tr>
<tr>
<td>Alliance for Safe Online Pharmacies—the ASOP Global Foundation</td>
<td><a href="https://asopfoundation.pharmacy">https://asopfoundation.pharmacy</a></td>
</tr>
<tr>
<td>The Center for Safe Internet Pharmacies</td>
<td><a href="https://safemedsonline.org">https://safemedsonline.org</a></td>
</tr>
<tr>
<td>LegitScript</td>
<td><a href="https://www.legitscript.com">https://www.legitscript.com</a></td>
</tr>
<tr>
<td>Verify Before You Buy through the Center for Safe Internet Pharmacies</td>
<td><a href="https://verifybeforeyoubuy.org">https://verifybeforeyoubuy.org</a></td>
</tr>
<tr>
<td>National Association of Boards of Pharmacy—Pharmacy Verified Websites program</td>
<td><a href="https://nabp.pharmacy/programs/accreditations-inspections/dotpharmacy">https://nabp.pharmacy/programs/accreditations-inspections/dotpharmacy</a></td>
</tr>
</tbody>
</table>
companies, and other organizations to shut down illegitimate online pharmacies and remove them from searches. These efforts should continue to improve the likelihood of patients and providers finding and purchasing the medications they need from legitimate websites.

Submitted October 25, 2021; final revision received January 20, 2022; accepted for publication January 24, 2022.


Disclosures: The authors have disclosed that they have not received any financial consideration from any person or organization regarding the preparation, analysis, results, or discussion of this article.

Correspondence: Sachiko Ozawa, PhD, MHS, Division of Practice Advancement and Clinical Education, UNC Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, CB#7574, Beard Hall 115G, Chapel Hill, NC 27599. Email: ozawa@unc.edu

References