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RESEARCH ARTICLE

Sexually Transmitted Infection Symptom Reporting to AI-Based Virtual Triage and Care Referral

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ABSTRACT

Objective: Evaluate the effectiveness of artificial intelligence-based virtual triage and care referral in describing, engaging and influencing care seeking behavior among patients with symptoms indicative of sexually transmitted infections.

Methods: Evaluated 4,487,191 virtual triage encounters among patients aged 12+ years over 36 months for sexually transmitted infections ranked as top three conditions. Demographics and type of care seeking before and following virtual triage were quantified and relationships assessed for statistical significance.

Results: A total 115,109 (2.6%) virtual triage encounters were consistent with a possible sexually transmitted infection. Most patients were female (64.5%) and 89.2% were aged 18–44. Over half of patients completed the virtual triage encounters in English or Spanish. Frequency of symptoms consistent with sexually transmitted infections reflected low detection rates due to the largely asymptomatic nature of these conditions. Of 5,717 patients completing pre- and post-triage care intent surveys, care seeking increased 6.1% post-triage ($p<0.05$); those uncertain about their care intent or planning no action decreased 20.0% ($p<0.05$). However, 46.3% of patients opted for contraindicated self-care measures post-triage, a 13.8% increase ($p<0.05$).

Conclusions: Virtual triage substantially influenced care seeking among individuals reporting symptoms suggestive of a sexually transmitted infection. Patients unsure how to address their symptoms or who planned inaction decreased significantly, while users intending to seek care increased. Virtual triage reduced indecision among patients by converting passive symptom acknowledgement into proactive intent to seek care. Increase in patients opting for self-care measures after virtual triage indicated a possible sexually transmitted infection, and despite a recommendation to seek care, suggests that certain barriers to care seeking for these infections may be too deeply rooted to be addressed by virtual triage technology alone.

Keywords: virtual triage and care referral; artificial intelligence; digital triage; sexually transmitted infections; telemedicine; STI disease control

Introduction

Sexually transmitted infection (STI) rates continue to rise globally and remain a significant public health challenge with low detection and treatment rates due to multiple barriers to care. In 2024, the World Health Organization (WHO) reported a large global increase of over 1 million STIs acquired daily.[1] In the USA, chlamydia, gonorrhea, and syphilis reached record highs in 2019, the sixth consecutive year of STI rate increases, with only a small decrease in 2023.[2-4] Sexually transmitted infections affect 1.2 billion people globally, mostly young in low and middle income countries.[5] Prompt diagnosis and treatment of STIs is imperative to reducing community transmission. Social factors influence STIs, including class, race, gender, and sexual orientation.[5-15]

While diagnosis and treatment of STIs have improved, social stigma remains a major barrier to testing and treatment, causing embarrassment and shame, fear of unfair judgment and discrimination, and results in delayed diagnosis and treatment.[9-11] Timely access to appropriate care is critical for preventing long-term complications and controlling community spread, but this access is often hindered by the asymptomatic nature of most STIs until late in

the course of illness.[16] It is estimated that 20% of the US population had an STI on any given day in 2018, yet only 2.2 million cases of chlamydia and gonorrhea were diagnosed, just 0.7% of the population. This is partly due to lack of symptoms, with only 6% of females and 11% of males with chlamydia and 45% of males and 14% of females with gonorrhea ever becoming symptomatic.[4,17,18]

Detection of STIs is further undermined by a majority of patients underestimating their STI risk and delaying care seeking. Over 85% of women and 70% of men perceived themselves as not at all or not very much at risk of STIs despite reporting high risk sexual behaviors.[19] Among individuals experiencing STI symptoms, over 38% reported delaying care seeking.[5] Care barriers include limited access to healthcare services, particularly in rural or underserved areas, socioeconomic inequities, social stigma, low sexual health literacy, financial impediments, and concerns about confidentiality.[12-15]

Innovative applications of health information technology have been explored to manage STIs and to enhance patient knowledge and symptom recognition. User reviews of an online sexual health symptom checker showed that the tool was perceived as providing helpful individualized, evidence-based health information to improve healthcare seeking.[10] One study found that online STI evaluation ameliorated some patients' feelings of shame and stigma.[11] Public use of symptom checkers and in particular artificial intelligence (AI)-based virtual triage and care referral (VTCR) has grown, as they offer an easily accessible form of remote healthcare, providing evidence-based clinical triage on the go. Due to their anonymity, online symptom checkers are a platform where patients can comfortably disclose STI symptoms, mitigating social stigma. By providing automated, anonymous health assessments on demand, virtual triage and care referral may reduce barriers related to accessibility and lack of health literacy.

Very little research has evaluated whether VTCR can improve patient ease and experience when reporting STI related symptoms, reduce stigma and care delays, and expedite appropriate care referral. AI-based VTCR has demonstrably improved post-triage clinical care acuity alignment, with 35% of patients altering care plans to match the recommendation of virtual triage.[20] Virtual triage and automated care referral can enhance early detection of high incidence and life-threatening conditions, potentially reducing diagnostic and care delays which negatively impact clinical outcomes.[21] It may potentially improve patient experience and improve STI detection and care referral. While studies have assessed the accuracy of virtual detection of STIs, few describe the patient demographics or impact of VTCR on patient care seeking behavior. The present study seeks to explore and reduce this knowledge gap.

Methods

STUDY OBJECTIVE:

To evaluate the utility of an AI-based VTCR engine in engaging patients with symptoms suggestive of STIs, and assess its effectiveness in helping them seek clinically appropriate healthcare. The study aimed to gather data on patient demographics and clinical characteristics in order to understand the potential role of VTCR in improving STI surveillance, detection and care delivery.

STUDY DESIGN:

A retrospective cohort design collected patient self-reported data and demographics through a free online VTCR engine, Symptomate, over a three-year period from October 2021 to October 2024. Patient reported pre- and post-triage healthcare seeking intentions were collected from April 1, 2022 to October 1, 2024, when the intent survey was implemented in the VTCR online platform.

SETTING AND DESCRIPTION OF INTERVENTION/ VIRTUAL TRIAGE ENGINE UTILIZED:

The Infermedica Symptomate VTCR engine is designed for general public use and completes evidence-driven analyses of 800 diseases, 1,500 symptoms, and 200 risk factors. Utilizing AI, VTCR assesses symptoms shared by patients and identifies probable conditions which correlate with the clinical presentation and history. Virtual triage then refers the patient to the safest and most acuity-level appropriate care by identifying potential somatic or mental health symptoms that warrant further professional evaluation. The VTCR encounter concludes by providing a summary and analysis of the patient's reported symptoms, along with a recommendation to engage self-care, visit a primary care or specialist physician on an outpatient basis routinely or urgently, or proceed to an emergency department (ED) via self-transport or ambulance. Data was extracted from the Symptomate application, which is available in 24 languages, and has over 19 million completed evaluations.

SAMPLE SELECTION AND INCLUSION/ELIGIBILITY CRITERIA:

During the 36-month study, a total of 4,487,191 VTCR encounters were completed by patients aged 12 or older. Study eligibility criteria included completed encounters in which the VTCR engine identified a sexually transmitted or related illness as one of the top three most likely conditions (Table 1), yielding a study sample size of N=115,109. Because data for these analyses were drawn exclusively from completed encounters, where all demographic variables were fully recorded, there was no need to

employ data imputation methods, nor were any cases excluded due to missing data.

DATA CAPTURE AND ANALYSES:
Prior to and after completing a VTCR encounter, patients could opt in to report their intended care seeking action, enabling a comparison of pre- and post-VTCR care seeking intent. This enables an assessment of the impact of VTCR in educating patients about and improving care acuity alignment, potentially reducing care seeking delays. Virtual triage and care referral recommendations were divided into four levels of care acuity: self-care, routine outpatient consultation when possible, urgent outpatient consultation (within 24h), and ED care. Cross-tabulations were completed and tables generated comparing male and female patient segments for symptom and care intent reporting.

ETHICS STATEMENT:
All patients in this study provided explicit consent prior to all VTCR encounters for their data to be used for research purposes, with analyses reported in a fully de-identified, anonymous manner in the aggregate. Ethics review board approval was waived as a result.

Results

PATIENT DEMOGRAPHICS AND MOST COMMON SEXUALLY TRANSMITTED INFECTIONS:

A dataset of 4,487,191 Symptomate encounters completed over the three-year study period was examined. Of these, 115,109 (2.6%) were consistent with a possible STI or STI-related condition and ranked as one of the top three likely conditions by VTCR (Table 1). Encounters may have been identified as having more than one STI or STI-related condition within the top 1-3 rankings. As a result, the total number of encounters in Table 1 exceeds 115,109; however, analyses were conducted on unique encounters to avoid duplication. Regarding patient demographics, 64.5% were female. Patients aged 18 to 44 years old comprised 89.2% of the sample. The encounter languages selected by patients were analyzed, with English most widely used (37.0%) followed by Spanish (20.0%) and French (9.6%). Less frequently used languages included Russian (7.6%), German (5.4%), Polish (5.1%), Portuguese (4.5%), Arabic (3.7%) and Italian (3.2%). Among all users, 3.4% of all encounters identified an STI as one of the top three conditions. The most common STI or STI-related condition was trichomoniasis (26,748 or 0.4% of all encounters and 23.2% of all unique STI encounters), gonorrhea (25,596 or 0.4% of all encounters and 22.2% of all unique STI encounters), and pelvic inflammatory disease (17,434 or 0.4% of all encounters and 15.1% of all unique STI encounters).

Table 1. Prevalence of Sexually Transmitted Infections in the Top Three Conditions Identified by Virtual Triage

STI-Related Condition	Number of VTCR Encounters	Percentage of Total VTCR Encounters (N=4,487,191)	Percentage of STI-Related Unique Encounters (N=115,109)
Trichomoniasis	26,748	0.6%	23.2%
Gonorrhea	25,596	0.6%	22.2%
Pelvic inflammatory disease	17,434	0.4%	15.1%
Genital herpes	15,236	0.3%	13.2%
Chlamydial genitourinary infection	14,679	0.3%	12.8%
Orchitis and epididymitis	12,867	0.3%	11.2%
Cervicitis	11,359	0.3%	9.9%
Urethritis	6,790	0.2%	5.9%
Anogenital warts/HPV infection	5,861	0.1%	5.1%
Acute HIV infection	5,841	0.1%	5.1%
Secondary syphilis	3,649	0.1%	3.2%
Primary syphilis	3,453	0.1%	3.0%
Acute hepatitis B	1,840	0.0%	1.6%
Acute hepatitis C	383	0.0%	0.3%
Total	151,736	3.4%	---

Notes: From October 1, 2021 through October 1, 2024.
VTCR – virtual triage and care referral; STI – sexually transmitted infection.

Tables 2 and 3 show the most commonly reported initial symptoms, or chief complaints, among female and male patients, respectively. Within the 74,271 total unique encounters completed by females,

125,348 total initial symptoms were reported. Accounting for multiple symptom reports to VTCR per individual encounter, the most frequently reported symptoms for females were genital or vulvovaginal itching (33.1%), abnormal vaginal discharge (22.3%), dysuria (14.7%), malodorous vaginal discharge (12.2%), abdominal pain (12.1%), and painful vaginal intercourse (10.4%).

Table 2. Most Frequently Reported Chief Complaint Among Females

Symptom	**Number of VTCR Encounters**	**Percentage of Unique STI-Related Encounters Completed by Females (N=74,271)**
Genital or vulvovaginal itching	24,606	33.1%
Abnormal vaginal discharge	16,595	22.3%
Dysuria	10,923	14.7%
Vaginal discharge with odor	9,086	12.2%
Abdominal pain (unspecified location)	9,005	12.1%
Painful vaginal intercourse	7,724	10.4%
Pelvic pain	6,962	9.4%
Fatigue	6,730	9.1%
Nausea	5,981	8.1%
Non-menstrual vaginal bleeding	5,976	8.0%
Headache	5,640	7.6%
Dermatological changes in genital area	5,470	7.4%
Vulvovaginal burning	5,382	7.2%
Urinary frequency	5,268	7.1%
Total	125,348	--
Note: From October 1, 2021 through October 1, 2024). VTCR – virtual triage and care referral; STI – sexually transmitted infection.		

Among males (Table 3), the most frequently reported chief complaints in 40,838 unique VTCR encounters were testicular/scrotal or crotch pain (33.9%), genital itching (17.8%), and dysuria (17.0%). These were followed by dermatological changes in the genital area (12.3%), urethral discharge (10.8%), and anal itching (8.0%). More vague or constitutional symptoms such as headache or nausea were reported less frequently among males relative to females.

PRE- AND POST-VTCR CARE SEEKING INTENT:
Findings among 5,717 patients who completed the pre- and post-triage care seeking intent surveys between April 1st, 2022, and October 1st, 2024 are shown in Table 4. Pre-VTCR, most intended to engage self-care or did not know/were uncertain about what care to seek (67.2%). Post-VTCR, intent to seek professional care increased by 6.1% to 39.0% ($p<0.05$). The proportion of patients uncertain of what care to pursue, or who planned to do nothing, decreased by 20.0% from 34.7% pre-triage to 14.7% post-triage ($p<0.05$). The percentage of patients who planned to manage their symptoms with self-care measures, clinically contraindicated for STIs, increased by 13.8% post-triage to 46.3% from 32.5% pre-triage ($p<0.05$). This was also contrary to VTCR output, where only 0.7% of triage recommendations were to self-care. The findings illustrate the difficulty in favorably influencing patient STI care intent, with almost half still planning self-care post-triage contrary to VTCR output, and a substantial proportion still not planning to consult a healthcare professional.

Table 3. Most Frequently Reported Chief Complaint Among Males

Symptom	Number of VTCR Encounters	Percentage of unique STI-Related Encounters Completed by Males (N=40,838)
Crotch pain, testicular or scrotal	13,845	33.9%
Genital itching	7,286	17.8%
Dysuria	6,928	17.0%
Dermatological changes in genital area	5,015	12.3%
Urethral discharge	4,402	10.8%
Anal itching	3,255	8.0%
Urinary frequency	2,745	6.7%
Fatigue	2,441	6.0%
Pelvic pain	2,078	5.1%
Scrotal edema	2,067	5.1%
Pelvic/perineal lymphadenopathy	2,060	5.0%
Pain in glans penis	2,017	4.9%
Abdominal pain (unspecified location)	1,899	4.7%
Total	56,038	--

Note: From October 1, 2021 through October 1, 2024.
VTCR – virtual triage and care referral; STI – sexually transmitted infection.

Table 4. Change In Patient Healthcare Intent Following Virtual Triage and Care Referral

	Pre-Triage Care Intent	Post-Triage Care Intent	Change in Care Intent Percentage Points/PP (Relative Change %)	Statistical Significance
Self-care	1,857 (32.5%)	2,648 (46.3%)	+13.8 PP (42.6%)	$p < 0.05$
Outpatient consult non-urgent	1,638 (28.7%)	1,873 (32.8%)	+4.1 PP (14.3%)	$p < 0.05$
Outpatient consult within 24h	98 (1.7%)	117 (2.0%)	+0.3 PP (19.4%)	$p > 0.05$
Emergency department care	143 (2.5%)	240 (4.2%)	+1.7 PP (67.8%)	$p < 0.05$
Not sure/do nothing	1,981(34.7%)	839 (14.7%)	- 20.0 PP (57.6%)	$p < 0.05$
Total	5,717 (100.0%)	5,717 (100.0%)		

Note: From April 1, 2022 through October 1, 2024.

Discussion

Symptoms consistent with STIs were observed at a rate of 2.6% in our study, which is in keeping with CDC data indicating that STIs like chlamydia and gonorrhea were diagnosed in only 0.7% of the US population in 2023.[4] This low detection rate reflects the predominantly asymptomatic nature of many STIs. Despite estimates suggesting that roughly 20% of the population have an STI in any given year, the vast majority experience little to no noticeable symptoms.[17,18]

The demographic distribution of elevated STI prevalence among the patients in this study is also consistent with global epidemiological data, where STIs more commonly affect younger adults.[4,22]

Patients aged 18 to 44 years old accounted for 89.2% of those with STIs. Higher representation of females (64.5%) in our dataset also may have contributed to an overall STI rate of 2.6%, as there is evidence that in the US males have higher STI incidence and higher likelihood of a symptomatic course relative to asymptomatic presentations among females.[18,23] The skew to higher general female use of VTCR may reflect greater female engagement of digital health tools and healthcare seeking among females, and aligns with other reports of public VTCR use.[24]

The ranking of different STI etiologies in this population aligns with statistical data on symptomatic

STI presentations. In the US chlamydia, trichomoniasis, genital herpes and human papillomavirus account for 97.6% of all prevalent and 93.1% of all incident STIs.[23] This is consistent with STI rates presented in Table 1, except for gonorrhea, which ranks higher. This discrepancy may be due to rarer conditions like gonorrhea presenting with symptoms more often than common asymptomatic infections like chlamydia, resulting in VTCR technology detecting them at higher rates.[18]

The reported changes in patient care intent present a complex picture in terms of improving care delivery to individuals with STIs. On the one hand, VTCR substantially (20.0%) reduced the number of patients uncertain of their care intent, or planning not to seek care, a positive impact. In these instances, VTCR successfully reduced patient indecision, inaction and care delay. There was also a statistically significant increase of 6.1% in the percentage of users intending to seek care following VTCR, observed most frequently in non-urgent outpatient consultations, which is often the most appropriate referral for many STIs. Thus, VTCR tools can transform passive STI symptom acknowledgment into proactive healthcare engagement and potential care seeking. On the other hand, a 13.8% increase in users opting for self-care measures post-VTCR is concerning since STIs are not treated with self-care measures. We suspect this includes patients planning to obtain telemedical care with at-home diagnostic assays and treatment. Further details on the specifics of self-care intent were not captured, and because "self-care" may be understood by some individuals as care involving at-home testing and virtual treatment, future studies should capture granular data on what is perceived as self-care intent. Overall, the results suggest VTCR can address certain barriers to STI care seeking by improving health awareness and education, demonstrated by the large reduction of patients post-VTCR who remain uncertain of how or whether to proceed.

Study limitations include that the care seeking intent survey was completed infrequently and thus may not be generalizable. Also, since a significant proportion of STIs are asymptomatic, self-reported STI symptoms may not impute to the broader population affected by STIs. Further, several conditions identified by VTCR included conditions with other etiology than STIs, such as orchitis and epididymitis. Finally, patient sampling may introduce systematic selection bias, as individuals who engage with digital health tools might differ from the general population in terms of health literacy, internet access, or care seeking behavior. The analysis also relied on self-reported healthcare intent, which may not fully translate into actual STI care seeking behavior, thus future studies should endeavor to validate the care actually sought.

Conclusions

Artificial intelligence-based VTCR substantially influenced care seeking among individuals reporting symptoms suggestive of STI. Prior to VTCR, over one-third of users were unsure how to address their symptoms or planned inaction. Following virtual triage, this proportion decreased significantly, while users intending to seek care increased. Virtual triage and automated care referral reduced indecision among patients by converting passive symptom acknowledgement into proactive intent to seek care. Virtual triage improved health awareness and can potentially expedite care access among patients reporting likely STIs, thereby achieving a positive public health impact. A concerning increase in users opting for self-care measures after VTCR indicated a possible STI, and despite a recommendation to seek care, suggests that certain barriers to STI care seeking such as stigma, financial concerns, trust or healthcare accessibility may be too deeply rooted to be addressed by VTCR technology alone. Nonetheless, the data demonstrated that VTCR can potentially support public health efforts to improve STI care seeking behavior.

Declarations

Clinical Trial: Not applicable.

Consent for Publication: All co-authors have reviewed and approved this article for publication.

Availability of Data and Material: Study data may be made available upon reasonable request.

Competing Interests: All authors are either employees of or medical advisors to Infermedica.

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Authors contributions: GAG, MM, GLG, TP, KT and MP designed the study methodology, completed analyses and interpreted the data; GAG, MM and GLG wrote and edited all drafts of the manuscript; GAG, MM, GLG, TP, KT and MP reviewed and organized the data presentation and validated the data analyses; GAG, MM and GLG wrote the initial draft and edited subsequent drafts of the manuscript; GLG assisted with project management, literature search, reference integration, and journal submission.

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