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Review Article

Public Health Section

A Comprehensive Review of Sexually Transmitted and Reproductive Tract Infection Through the Lens of History: Current Realities and Future Strategies

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ABSTRACT

Sexually Transmitted Infections (STIs) and Reproductive Tract Infections (RTIs) have significantly influenced human health, societal norms and medical practices throughout history. From ancient references to the modern Human Immunodeficiency Virus (HIV) pandemic, STIs/RTIs have shaped public health responses and awareness. The present review synthesises historical developments, global epidemiological trends and contemporary management approaches, with a focus on India. Unique to this paper is its comparative evaluation of syndromic and aetiological management, tabulated diagnostic approaches and integration of India's National Acquired Immunodeficiency Disease (AIDS) Control Programme (NACP) Phase V strategies. The review also identifies key challenges in surveillance, asymptomatic case management and healthcare worker training. The present review uniquely integrates a detailed historical trajectory of STIs/RTIs- from ancient medical texts to modern epidemics- while linking these lessons to current diagnostic strategies, syndromic management and India's NACP Phase V framework. This historical perspective provides a broader context for understanding persistent challenges and shaping future interventions. In conclusion, while India has made significant progress through structured national programmes, gaps remain in early diagnosis, awareness and resource accessibility. Strengthening surveillance, adopting global best practices and integrating digital technologies are essential for future progress. The present review offers an overview of STIs/RTIs by integrating historical context, epidemiology and current prevention and management strategies, with a particular focus on India.

Keywords: Epidemiological trends, Healthcare system, Reproductive health, Social stigma, Syndromic management

INTRODUCTION

Sexually Transmitted Infections (STIs) and RTIs remain among the most pressing public health challenges worldwide, exerting a significant burden on reproductive, maternal and neonatal health outcomes. These infections, caused by diverse bacterial, viral and parasitic agents, affect millions of individuals across all socioeconomic groups. According to the World Health Organisation (WHO), more than one million new STIs are acquired every day globally, underscoring the magnitude of the problem [1]. Beyond immediate morbidity, these infections contribute to long-term complications such as infertility, ectopic pregnancy, pelvic inflammatory disease, adverse pregnancy outcomes and increased susceptibility to HIV [1]. Their impact extends beyond health into social and economic domains, often reinforcing gender disparities, stigma and discrimination that hinder individuals-particularly women-from accessing timely care and treatment.

Common STIs such as chlamydia, gonorrhoea, syphilis, Human Papillomavirus (HPV), hepatitis B and HIV illustrate the widespread nature of these infections. Many remain asymptomatic and undiagnosed, thereby perpetuating transmission within communities. In low- and middle-income countries, including India, barriers such as inadequate healthcare infrastructure, limited awareness, social taboos surrounding sexual health and economic constraints further exacerbate the situation. Even when treatment options exist, antimicrobial resistance- particularly in gonorrhoea-poses an emerging global threat [2]. The cumulative effect is not only compromised individual health but also substantial strain on already overburdened healthcare systems.

Historically, STIs have affected societies for centuries, shaping medical knowledge, public health systems and cultural perceptions of disease. The historical trajectory from early recognition of syphilis in the 15th century to the HIV/AIDS pandemic of the late 20th century offers valuable lessons regarding the evolution of diagnostic technologies, treatment modalities and preventive strategies. While early approaches were limited by poor understanding of pathogens, the development of antibiotics, vaccines (such as those for HPV and hepatitis B) and antiretroviral therapies marked significant turning points in STI management. However, contemporary realities indicate that stigma, inequities and emerging resistance continue to hinder effective control [3].

In India, the public health response to STIs and RTIs has evolved considerably. Earlier reliance on the syndromic management approach improved service accessibility at the primary care level but often failed to identify asymptomatic and subclinical cases, thereby limiting its effectiveness. Current national strategies, such as the National AIDS Control Programme (NACP) Phase V, represent structured efforts to integrate prevention, testing, treatment and counselling services into broader health systems [3]. Despite these advances, challenges remain in ensuring universal access, reducing stigma and aligning national efforts with global best practices recommended by organisations such as WHO and United Nations Programme on HIV/AIDS (UNAIDS).

The present review provides a comprehensive overview of STIs/RTIs through historical context, epidemiological analysis and current prevention and management strategies, particularly within the Indian setting. We critically examine the strengths and limitations

of existing programmes, propose actionable solutions and highlight areas requiring further research and policy attention.

Given its scope and objectives, the present review adopts a narrative approach, enabling the integration of evidence from historical sources and peer-reviewed literature. The aim is to synthesise historical, epidemiological and contemporary management perspectives on STIs and RTIs, with special emphasis on India.

DISCUSSION

Historical perspectives of STIs/RTIs: STIs and RTIs have left a profound mark on human history, dating back to ancient civilisations. Early references in texts such as the Ebers Papyrus and Leviticus indicate awareness of conditions resembling gonorrhoea. Greek and Roman scholars, including Hippocrates and Galen, contributed significantly to early understanding, with Galen coining the term "gonorrhoea" around 2nd century AD. Treatments during this period included herbal preparations, topical applications, dietary restrictions, bloodletting, astringents and ritual cleansing [4].

During the Islamic Golden Age, scholars such as Avicenna and Maimonides further advanced understanding and recommended therapies including honey, vinegar, sitz baths and herbal compounds [5]. Medieval Europe witnessed further developments through scholars such as Roger of Salerno and John of Gaddesden, where treatments often combined humoral balancing techniques (phlebotomy and purging) with topical salves. The contagious nature of gonorrhoea was increasingly recognised during outbreaks across Europe, often managed with irrigations and cauterisation [6].

The origins of syphilis sparked considerable debate, with theories ranging from its presence in pre-Columbian Europe to its introduction by Columbus's sailors [7]. Fracastoro popularised treatments involving mercury and guaiacum, while Fallopius and Fernel made notable contributions in the 16th century. The concept of the condom emerged later, with Turner's early descriptions in 1717. Paracelsus's assertion linking syphilis and gonorrhoea further complicated early understanding [8].

Medical advances continued into the 19th century, with Ricord's differentiation of gonorrhoea and syphilis and Neisser's identification of gonococci. Finger's work in 1888 further advanced gonorrhoea diagnostics [9]. The Industrial Revolution facilitated rapid urbanisation, contributing to rising STI rates, which were countered by parallel progress in microbiology and public health measures [10]. This period also witnessed the reorganisation of medical education, broadening access and fostering the growth of public health medicine [11].

19th century advancements in STIs: During the 19th century, the rise of nation-states introduced new dimensions to health regulation, particularly in the understanding and control of STIs. Parent-Duchâtelet's 1837 work established a link between prostitution and STIs, laying the foundation for systematic epidemiological research [12]. Bassereau's 1852 differentiation of chancroid from syphilis, Diday's 1854 description of congenital syphilis and Fournier's 1875 association of syphilis with neurological disorders significantly advanced clinical understanding [13].

Edwin Klebs' discovery of spirochaetes in syphilitic tissue in the late 19th century marked a major breakthrough [14]. Progress also continued in the study of other STIs, with Halberstaedter and Prowazek identifying inclusion bodies related to trachoma in 1907 and Lindner contributing to the understanding of non gonococcal urethritis. Harkness later recognised it as a distinct clinical entity in 1950 and Chlamydia trachomatis was isolated in 1959 [15,16].

Donovanosis, initially described by Macleod in 1881, had its causative organism identified by Charles Donovan in 1905. Despite scientific progress, STIs continued to exert profound physical and psychological effects on affected individuals [17]. The emergence of HIV/AIDS in 1981 introduced unprecedented public health, moral and economic challenges, highlighting the need for advanced epidemiology, public education, condom promotion and vaccine research [18].

From 900-1100 AD, Avicenna recommended urethral irrigation for urethral discharge in his Canon of Medicine [5]. In 1530, Girolamo Fracastoro popularised mercury and guaiacum for syphilis treatment. During the 16th century, Fallopius employed cauterisation and cleansing methods but did not advocate condom use. In the 19th century, Philippe Ricord's differentiation of gonorrhoea and syphilis reshaped global medical education [10].

Microbiological breakthroughs by Pasteur and Koch paved the way for Albert Neisser's 1879 discovery of gonococci. Crédé's 1883 silver nitrate prophylaxis dramatically reduced ophthalmia neonatorum. Finger's 1888 research further refined diagnostic approaches [19]. Wallace introduced potassium iodide therapy for syphilis in 1835 [20].

Paul Ehrlich's 1909 discovery of Salvarsan revolutionised syphilis treatment, followed by malarial therapy for general paresis in 1917. Bismuth remained a treatment option until the mid-20thcentury [21].

Societal and medical challenges in managing STIs/RTIs: In the late 19th and early 20th centuries, societies grappled with fear, misinformation and moral judgement surrounding STIs. Similarly, the HIV/AIDS epidemic in the 20th century generated widespread stigma due to its association with marginalised populations, undermining trust in scientific institutions [22].

Physicians and reformers recognised the necessity of public education but faced resistance rooted in social taboos and Victorian sexual ethics. Early campaigns often relied on fear-based messaging, inadvertently intensifying stigma. Despite these efforts, infection rates remained high, prompting pragmatic strategies during World War II, including widespread condom distribution and separation of morality from disease prevention.

Although biomedical advances led to substantial declines in syphilis and gonorrhoea by the 1950s, resurgences occurred in the 1960s and 1980s, underscoring the need for sustained education, funding and public health engagement [23]. The complexity of HIV/AIDS demanded comprehensive responses integrating scientific, social and political strategies. Biomedical interventions alone proved insufficient without addressing broader societal determinants of health [24].

Extent of problem

Global burden of STIs/RTIs: STIs continue to impose a major global burden, with over one million new infections acquired daily and an estimated 374 million cases annually in 2020 [1]. Major contributors include chlamydia (129 million), gonorrhoea (82 million), syphilis (7.1 million) and trichomoniasis (156 million). Genital herpes affected over 490 million individuals in 2016, while approximately 300 million women worldwide are infected with HPV, a leading cause of cervical and anal cancers, particularly among men who have sex with men. Additionally, nearly 296 million people live with chronic hepatitis B globally [1].

In India, STI prevalence is estimated at 5-6% annually among adults; however, comprehensive national surveillance data remain limited [25]. Clinic-based reports suggest 7-9 million cases are treated each year, reflecting the widespread nature of these infections. Numerous studies reveal substantial reproductive health morbidity among adolescents and women, especially in rural populations [26-28]. Cervical cancer, largely attributable to HPV infection, accounts for approximately 67,477 deaths annually in India [26].

Data on congenital syphilis remain sparse, with approximately 16,023 reported cases in 2015-2016, underscoring gaps in surveillance and reporting systems [29]. These figures highlight the urgent need for strengthened prevention, diagnosis and monitoring frameworks. The complex interplay of biological, social and

behavioural factors influencing STI transmission is summarised in [Table/Fig-1] [1,30-32].

Study	Place/year of the study	Study population/ setting	Key findings/Risk factors
WHO overview/ Global context [1].	Global/2022	Global, general population	STIs/RTIs influenced by social, economic, biological factors - Community disruptions and commercial sex networks increase transmission - Iatrogenic infections common in resource-limited areas, especially postpartum/ postabortion - Yeast infections affected by hormonal and environmental factors - HIV emergence worsened STI burden, especially in areas with sexual violence and limited condom access
Kurewa NE et al., (Zimbabwe) [30]	Peri-urban health clinics around Harare, Zimbabwe/2002–2003	Pregnant women	Age >30 years - Polygamous relationships - Low income - Multigravidity - Multiple sexual partners - Children with different paternity - Clinical signs: genital warts, genital ulcers, *Trichomonas vaginalis* infection - Early sexual debut (<20 years) associated with vaginal infections
Hawkes S et al., [31]	Rural Bangladesh/2002	Women and men in high-risk settings	Women with multiple marriages at higher risk of treatable STIs - Husbands in casual work increase risk - Men aged 25-34 years are especially vulnerable to *Chlamydia* and syphilis - Women working outside the home or with symptomatic partners more likely to get viral STIs (HSV-2) - Hygiene practices (e.g., sanitary protection change, vaginal douching) showed no strong association
Chaudhary N et al., [32].	Lucknow, Northern India (tertiary care centre)/2017	Women in India	Illiteracy - Low socio-economic status - Specific occupations - History of RTI - Partner with STI symptoms - Intrauterine Device (IUD) use - Repeated use of cloth during menstruation

[Table/Fig-1]: Factors responsible for occurrence and transmission of STIs/RTIs [1,30-32].

Diagnosis of STIs/RTIs: Diagnosis of STIs and RTIs involves comprehensive history taking, clinical and gynaecological examination and laboratory investigations. Gonorrhoea diagnosis commonly includes microscopy, culture, DNA probe testing and Polymerase Chain Reaction (PCR) assays. Detection of Chlamydia trachomatis employs Direct Fluorescent Antibody (DFA), Enzyme Immunoassay (EIA), culture, Deoxyribonucleic Acid (DNA) probe methods and PCR.

Syphilis diagnosis relies on dark-field microscopy for Treponema pallidum, along with non treponemal and treponemal serological tests. Chancroid identification involves Gram staining and microscopy of Gram negative coccobacilli, while granuloma inguinale diagnosis utilises Giemsa staining.

Bacterial vaginosis is assessed through microscopy and vaginal pH testing. Candidiasis is diagnosed by microscopy and culture for yeast and hyphae. Trichomoniasis detection includes wet mount microscopy, culture and Nucleic Acid Amplification Tests (NAATs). Herpes Simplex Virus (HSV) diagnosis involves microscopy, viral culture and antigen or antibody detection. HPV diagnosis relies on clinical evaluation and nucleic acid testing. Hepatitis B and C infections are confirmed using antigen/antibody assays and nucleic acid testing.

These diagnostic strategies are essential for accurate identification and effective management of STIs and RTIs [33].

Management of STIs/RTIs: The two primary approaches to the diagnosis and management of STIs/RTIs are the aetiological approach and the syndromic approach. The aetiological approach relies on laboratory investigations to identify the specific causative organism, thereby guiding targeted treatment. However, this method is often inaccessible in low- and middle-income countries due to limitations such as the need for trained personnel, specialised equipment and repeated patient visits for testing and treatment.

In contrast, the syndromic approach, widely used in resource-limited settings, is based on the identification of consistent symptom and sign patterns. This strategy does not require laboratory confirmation, making it more feasible and cost-effective. By recognising clinical syndromes, healthcare providers can initiate immediate treatment, thereby improving accessibility and reducing delays in care.

The National Guidelines on the Management of STIs/RTIs incorporate seven key syndromes and provide flowcharts to guide healthcare workers in diagnosis and treatment. These flowcharts outline the clinical presentation, associated infections, causative organisms, differential diagnosis, recommended history taking and physical examination, necessary investigations, treatment regimens, referral criteria, partner management and special considerations during pregnancy [33].

Seven pre-packaged, colour-coded STI/RTI drug kits were introduced by the Ministry of Health and Family Welfare in August 2007 to facilitate syndromic management [Table/Fig-2]. These kits are provided free of cost at all public STI/RTI service facilities, including designated STI clinics and targeted intervention sites [33].

Kit Number	Syndrome	Colour	Contents
Kit 1	Urethral Discharge (UD), Cervical Discharge (CD), Anorectal Discharge (ARD), Painful Scrotal Swelling (PSS), Presumptive Treatment (PT)	Grey	Tab. azithromycin 1 g (1) and Tab. cefixime 400 mg (1)
Kit 2	Vaginal Discharge (VD)	Green	Tab. secnidazole 2 g (1) and Tab. fluconazole 150 mg (1)
Kit 3	Genital Ulcer Disease - Non Herpetic (GUD-NH)	White	Inj. benzathine penicillin 2.4 MU (1) and Tab. azithromycin 1 g (1) and disposable syringe 10 mL with 21 gauge needle (1) and sterile water 10 mL (1)
Kit 4	Genital Ulcer Disease- Non Herpetic (GUD-NH) - for patients allergic to penicillin	Blue	Tab. doxycycline 100 mg (30) and Tab. azithromycin 1 g (1)
Kit 5	Genital Ulcer Disease - Herpetic (GUD-H)	Red	Tab. acyclovir 400 mg (21)
Kit 6	Lower Abdominal Pain (LAP/PID)	Yellow	Tab. cefixime 400 mg (1) and Tab. metronidazole 400 mg (28) and Cap. doxycycline 100 mg (28)
Kit 7	Inguinal Bubo (IB)	Black	Tab. doxycycline 100 mg (42) and Tab. azithromycin 1 g (1)

[Table/Fig-2]: Syndromic management kits for Sexually Transmitted Infections (STIs) and Reproductive Tract Infections (RTIs) [33].

Despite its practicality, syndromic management fails to detect asymptomatic infections such as chlamydia, gonorrhoea, HPV, hepatitis B and genital herpes. These undiagnosed cases contribute significantly to complications including pelvic inflammatory disease and infertility. More than 75% of women infected with Chlamydia trachomatis remain asymptomatic, underscoring the need for expanded screening and laboratory-based diagnostics [34].

Programs and preventive measures to control STI/RTI: The National AIDS Control Programme (NACP) Phase V (2021–2026) outlines a comprehensive strategy for STI/RTI prevention and management, recognising its critical role in controlling HIV and syphilis transmission while improving access to quality services. Key priorities include strengthening surveillance systems, enhancing monitoring and research and improving strategic information on STIs [3].

Currently, India has 1,184 Designated STI/RTI Clinics (DSRCs) located in district hospitals and medical colleges within departments of gynaecology, dermatology and venereology. High-risk groups receive services through 1,477 Targeted Intervention (TI) sites. Additionally, 45 State Reference Centres (SRCs) and 10 Regional STI Training, Research and Reference Laboratories (RSTRRLs) support diagnostic and management services under the NACP framework.

Between January and September 2022 alone, over 3.5 lakh general clients and 2.35 lakh high-risk group individuals were managed through DSRCs and TI sites. These DSRCs, also known as Suraksha Clinics, continue to serve as primary service delivery points, incorporating innovative strategies such as the Sampoorna Suraksha Initiative [35].

Integrated communication campaigns target shared behavioural risk factors for HIV and STIs, while dual testing for syphilis at existing HIV Counselling and Testing Services (HCTS) centres aims to improve early detection. Active case-finding strategies, including index testing and social network approaches, are being promoted. Collaboration with the National Health Mission enables service expansion through Reproductive, Maternal, Newborn, Child and Adolescent Health (RMNCH)+A and Adolescent Reproductive and Sexual Health (ARSH) Clinics.

Private sector engagement is being strengthened through training programmes and reporting mechanisms. Regular updates to national guidelines incorporate advances in diagnostics and service delivery, while laboratory infrastructure and supply chains are being optimised through IT-enabled systems. Collectively, NACP Phase V represents a proactive, integrated and scalable approach to STI/RTI control [36].

Challenges faced and suggestions to overcome the burden: Critics of syndromic management highlight its inability to detect asymptomatic infections, thereby sustaining ongoing transmission and long-term complications [37]. A study from South Africa demonstrated that clinical assessment failed to identify 88% of laboratory-confirmed STIs in women newly diagnosed with HIV, prompting calls for more aggressive interventions such as mass treatment strategies.

Modelling studies suggest that while single-round mass treatment may yield short-term reductions in HIV incidence, combining it with sustained syndromic treatment produces more durable outcomes. Emerging digital health technologies offer cost-effective, engaging tools for STI/HIV prevention, education and follow-up. Additionally, Expedited Partner Therapy (EPT) has shown promise in reducing reinfection rates, particularly for chlamydia in women.

However, syndromic algorithms require continuous evaluation to reflect evolving epidemiological trends. Poor concordance between syndromic diagnosis and laboratory-confirmed infections, especially in high HIV-prevalence regions, remains a major concern. Updated clinical algorithms, expanded diagnostic access and improved healthcare worker training are essential [36,38].

Paramedical staff often lack adequate knowledge of STI/RTI management, further limiting programme effectiveness. Structured training programmes lasting two to three days have demonstrated measurable improvements in clinical competence, as observed in international settings such as Peru. Ongoing capacity-building initiatives are therefore critical for sustained success.

CONCLUSION(S)

Despite centuries of medical progress- from early mercury-based therapies to modern antibiotics and antivirals- STIs and RTIs remain major global health challenges, with more than 374 million new infections occurring annually. While syndromic management has enhanced treatment accessibility in resource-limited settings, it fails to address the substantial burden of asymptomatic infections, which account for over 75% of cases in conditions such as chlamydia.

The persistence of STIs reflects a complex interplay of biological, behavioural, social and economic factors. Future strategies must prioritise affordable point-of-care diagnostic technologies for early detection, strengthened surveillance systems, comprehensive epidemiological research and the integration of digital health innovations. Together, these efforts are essential for achieving sustainable reductions in STI/RTI transmission and improving sexual and reproductive health outcomes.

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