

Impact of sexually transmitted infections on women health*

Manisha Yadav^{1#}, Neha Verma¹, Rakesh Singh Dhanda²

¹Dr. B. R. Ambedkar Centre for Biomedical Research, University of Delhi, Delhi, India;

[#]Corresponding Author: manisha.dhanda@gmail.com, myadav@acbr.du.ac.in

²Department of Translational and Regenerative Medicine, Post Graduate Institute of Medical Education & Research, Chandigarh, India

Received 1 June 2013; revised 2 July 2013; accepted 20 July 2013

Copyright © 2013 Manisha Yadav *et al.* This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Sexually transmitted infections (STIs) are the infections that can be transmitted from one sex partner, who already has such infection, to another. The causes of STIs in human are very well elucidated and their causative agents are identified as bacteria, parasites and viruses. The worldwide epidemiology of more than 20 types of STIs has been established, which includes diseases like Chlamydia, Gonorrhea, Genital herpes, HIV/AIDS, HPV, Syphilis and Trichomoniasis. Though STIs affect both men and women indiscriminately, however, the pathophysiology of disease is more obvious among women. Other than abstinence, the most effective way to prevent the transmission or acquisition of STIs is to use a condom during sexual intercourse. Condoms are effective in decreasing the transmission of HIV. However, once contacted, STIs caused by bacteria or parasites can be treated with antibiotics. STIs caused by a virus may not virtually have any cure though the medicines may keep the disease under control. Correct usage of preventive measures greatly reduces but does not completely eliminate the risk of catching or spreading STIs.

Keywords: Sexually Transmitted Infections; Syphilis; Gonorrhea; Chlamydia; Trichomonas; Genital Herpes; HPV; HIV

1. INTRODUCTION

Sexually transmitted infections (STIs) also known as

venereal diseases are transmitted by means of human sexual relationships. Bacteria, fungi, protozoa or viruses are the major known causative agents for such diseases. According to 2005 WHO estimate, annually 448 million new cases of curable STIs occur throughout the world in adults aged group which mainly includes infections caused by organisms like *C. trachomatis*, *T. vaginalis* and *Neisseria gonorrhoea*. However, this evaluation does not include HIV and other STIs. The prevalence of STIs in developing countries like India is found to be 6% and out of this, approximate 40% of women have various STIs at any given point of time [1]. On acquiring STIs, women become prone to acquire a non-curable STIs like the human immunodeficiency virus (HIV) or the herpes simplex type II virus.

Approximately 21% of the people with HIV infection are unaware of them being infected and thus increase the transmission of the virus to their sexual partners, although it has been found that individuals who have ulcerated type of STIs are more susceptible to HIV infection [2-4] as compared to non-ulcerated types [4]. Viral infections in pregnancy are known causes of morbidity and mortality for both child and the mother. Infections are also capable of occurring through placenta, perinatally (from vaginal secretions or blood) or postnatally (from breast milk or other sources) [5]. It is known that most of the STIs exist without symptoms (asymptomatic) since it is reported that more than half of the women and also a significant proportion of men with Gonococcal, Chlamydial, Trichomonal and other infections experience no symptoms at all [6]. But such symptomatic and asymptomatic infections can lead to the development of serious complications like cervical erosion, endometritis, pyosalpinx, low birth weight, preterm birth, peritonitis, ectopic pregnancy, increased risk of HIV infection in women, if left untreated.

It is widely believed that factors like the assortative

*Conflicts of interest: The authors have no conflicting financial interests.

mixing between people with large numbers of sexual partners, low literacy status, high-risk sexual activities, past infections in male partners and cases of transfusion of blood can play a major role in transmission of STIs [7]. STIs like HIV are known to spread among non-infected individuals with the use of infected needles which they use for injection of drugs. Einwalter [8] reported that the Caucasians and the younger African-American women, with multiple sexual partners, are at increased risk of acquiring STIs like Chlamydia and Gonorrhea. The best and effective way to prevent the transmission of such STIs, other than abstinence, is to use a condom during sexual intercourse. Condoms are very effective in decreasing the transmission of not only Gonorrhea, Chlamydia, Trichomonas and Hepatitis [9] but also HIV [4,10]. However, the condom fails to provide the effectiveness to a large extent in transmission of known infections like syphilis, HPV, chancroid and genital herpes. [11]. STIs may act as stronger risk factors for HIV transmission in developing countries like India because of socio-economic barriers to treatment [12]. The main aim of this article is to emphasize the impact of different sexually transmitted infections on health of women and further consequences of these infections on health of new born child.

2. MAJOR PATHOGENS

The major pathogens responsible for causing various STIs are as follows.

2.1. Chlamydia

Chlamydia infection is cosmopolitan and caused by the bacterium *Chlamydia trachomatis*. According to the WHO, 90 million people worldwide are found to be infected with Chlamydia annually [13]. *C. trachomatis* is the major and common cause of mucopurulent cervicitis [14], urethritis [15], pelvic inflammatory diseases [16], ectopic pregnancy [17] associated with Chlamydia infection in women. They can also lead to complications like premature rupture of membranes, chorionamnionitis, premature delivery and neonatal infections [18-20]. Along with this *C. trachomatis* is also known to play cofactor role in cervical carcinomas [6]. Chlamydia can be transmitted through vaginal sex and other modes of sex that includes oral sex and anal sex and are known to be transmitted from an infected mother to her baby during the time of birth. More than 50 percent of women who have a Chlamydia infection of the cervix are asymptomatic. If untreated, chlamydial infections can cause serious reproductive and other health problems with both short-term and long-term problems like ectopic pregnancy and serious pelvic pain [21]. It is well known that *C. trachomatis* infection increases chances of squamous

cell carcinoma in women [22].

Since Chlamydia infection can be easily treated, therefore it becomes an important therapeutic target for treatment of cervical neoplasia. Its contribution in dysplasia and neoplasia has been attributed to epithelial damage allowing easy HPV virion entry [23]. Chlamydia is known to be associated with 8 fold increase in risk of unhealthy cervix [24]. These deceptively mild symptoms allow the infection to go unnoticed. With minimal patient awareness, the secondary or the tertiary symptoms develop with time and thus become noticeable [25]. Infertile women with tubal diseases are 2 to 4 times more likely to have increased immune response than either infertile women with normal tubes or pregnant women. Surana *et al.* [25] stated that the Chlamydial infections were more likely to be associated with peripheral endosalpingitis, thus making a large contribution towards bilateral tubal damage causing infertility.

2.2. Gonorrhea

Gonorrhea is a STI caused by *Neisseria gonorrhea* for which humans are the natural host [26]. Following Chlamydia, Gonorrhea is the second most commonly reported bacterial STI in the United States. The highest rates of Gonorrhea are among teenagers, young adults and African American who are involved in sexual activities. The causative organism is highly adapted to the genital tract keeping the infection asymptomatic and undetected in most of the women. Women have a 60% - 80% risk of getting the infection from a single act of vaginal intercourse with an infected man [27]. A mother may transmit gonorrhea to her newborn during childbirth. But it has also been estimated that 8% - 16% of women with untreated endocervical gonococcal infections tend to develop acute salpingitis causing an ascending spread of the pathogens. Even after a single episode of acute salpingitis, almost 10% of women may become infertile due to the complete tubal occlusion. In similar manner, the chances for women to develop pelvic inflammation disease, ectopic pregnancy [3] after salpingitis is 6 - 10 times greater. Ectopic pregnancies in areas where there are insufficient health services carry a high mortality risk.

Gonorrhea can spread into the complete or a part of reproductive system of women, resulting in pelvic inflammatory disease (PID). PID affects more than 1 million women in the United States every year and can cause tubal (ectopic) pregnancy and infertility in as many as 10 percent of infected women.

2.3. Syphilis

Syphilis is a STI caused by the spirochete bacterium *Treponema pallidum*. Though the primary route of transmission is through various sexual activities, however it is

also transmitted from mother to fetus either during pregnancy or at the time of child birth, which may result in chances of congenital syphilis. The various symptoms shown by patients may vary depending in which of the four stages it represents (primary, secondary, latent and tertiary) [28]. The primary stage classically represents with a single chancre (a firm, painless, non-itchy skin ulceration); secondary syphilis with a diffuse rash which frequently involves the palms of the hands and soles of the feet; latent syphilis with little or no symptoms; and tertiary syphilis with gummas, neurological, or cardiac symptoms. Syphilis is thought to have infected 12 million people worldwide in 1999, with greater than 90% of cases in the developing world [29]. It affects around 1.6 million pregnancies a year, resulting in spontaneous abortions and stillbirths. It has also been stated that syphilis has the tendency to increase risk of HIV transmission by two to five times, and co-infection with other pathogens is very common [28,29].

Institutes like the US Preventive Service Task Force (USPSTF) recommends syphilis screening for those women who are engaged in high risk sexual behavior which includes multiple partners, inconsistent use of condom, engaged in sex under the influence of abusive substances like alcohol and drugs, or for financial purposes [30,31]. Therefore, screening for syphilis is majorly done in case of pregnant females as the complications in the treatment of newborn are very high. Mother to child transmission of this infection is due to the undiagnosed, untreated, or inadequately treated maternal syphilis, which can result in a number of adverse pregnancy outcomes like preterm birth fetal death, low birth weight and sometimes neonatal death also. This occurs because of the direct damage that is being caused to both placenta and umbilical cord, which further compromises with the fetal health and growth. It has been estimated that if left untreated, syphilis in pregnancy can directly cause severe outcomes in around 50% of cases [32]. As compared to this, in HIV infected pregnant female, the in-utero transmission is around 20% with an additional transmission at the time of delivery or during breastfeeding.

2.4. Genital Herpes

Genital Herpes is a viral disease caused by both Herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). The visible symptoms of the most common forms are in the form of oral herpes. These are evident by *cold sores* or *fever blisters* as infections of the face or mouth. Genital herpes, commonly known as herpes, is said to be the second most common form of herpes infection [33]. The typical clinical features shown are painful shallow anogenital ulceration. HSV-1 is also known to cause gin-

givostomatitis and oro-labial ulcers whereas HSV-2 can also cause vesicular and ulcerative lesions in adults [33]. Along with this, both virus types have the tendency to cause infection of the central nervous system. HSV-1 and HSV-2 are capable of causing a first episode of infection to the genital areas, but HSV-2 causes repeated cases of infection [34]. Most of the people infected with HSV-2 present only mild symptoms and remain unaware of the infection. However, such people can still pass on the infection to their sexual partners and newborns [35,36]. The other effects of herpes simplex virus infection include aseptic meningitis, urinary retention, infection to neonatal, opportunistic infection in those patients who are suffering from infections like HIV or the ones who give reports of recurrent infections and psychosocial morbidity [36]. Moreover, HSV-2 infection is known to be associated with an increased risk of HIV transmission and acquisition [37]. In a series of cross-sectional national surveys from 1976 to 2004 conducted by the National Center for Health Statistics, it was observed that overall HSV-2 sero prevalence rises rapidly in younger age groups and then remains stable among older population [38,39]. However, HSV-2 prevalence is negligible among persons who have never been sexually active [40].

Worldwide rates of either HSV-1 and/or HSV-2 are between 60% - 95% in adults [41]. HSV-1 rates are between 70% to 80% in populations of low socio-economic status and 40% to 60% in populations of improved socio-economic status [41]. Prevalence of HSV-2 in those between the ages of 15 and 50 was reported to be approximately 535 million or 16% of the population with greater rates among women and in those in the developing world [42]. An estimated 536 million people worldwide were infected with HSV-2 worldwide, with the highest rates in sub-Saharan Africa and the lowest rates in Western Europe [42]. In the US, 58% of the population is infected with HSV-1 and 16% are infected with HSV-2 [39]. Therefore, HSV-1 is more common than HSV-2 with rates of both increasing as people age.

2.5. Human Papilloma Virus (HPV)

HPV is one of the most important factors which play a major role in causing cervical cancer in women. Annual incidence of cervical cancer in India is about 130,000 cases with 75 - 80,000 deaths. Thus India shares about one fourth of the global cervical cancer burden [43]. According to the Centers for Disease Control and Prevention, approximately 6 million new cases of sexually transmitted HPV infections are reported every year. At least 20 million people in India are already infected. Genital warts are the most easily recognized sign of genital HPV infection. There are reported cases of geni-

tal HPV infection with or without genital warts. Genital warts appear to be soft, moist colored and appear in the genital area within weeks or months of infection. They at times give the appearance of cauliflower-like bumps which are raised or flat, small or large. Genital warts show up in women on the vulva and cervix and inside and surrounding the vagina and anus. There are cases where genital warts have been found on the thigh and groin. Persistent infection with “high-risk” HPV types which are different from the ones that may cause invarient skin warts, it may also progress to precancerous lesions [44]. HPV infection is a cause of nearly all cases of cervical cancer [45].

Over 120 HPV types have been identified and are referred to by number. But around dozen HPV types (including types 16, 18, 31 and 45) are called “high-risk” types because they can lead to various cancers like that of cervical and anal. However, several types of HPV, like type 16 has been found to be associated with HPV-positive oropharyngeal cancer (OSCC), a form of head and neck cancer [46]. HPV-induced cancers often have viral sequences integrated into the cellular DNA. Some of the HPV early genes like E6 and E7 act as oncogenes that promote tumor growth and malignant transformation. Infection caused to oral regions due to presence of HPV may increase the risk of OSCC independent of tobacco and alcohol use [46]. In the United States, HPV is expected to replace tobacco as the main causative agent for oral cancer. High-risk oncogenic HPV types (including HPV 16 and HPV 18) are associated with 99.7% of all cervical cancers [47].

Most HPV infections in young females are temporary and have little long-term significance. 70% of infections are gone in one year and 90% in two years [48]. However, the infection persists in 5% to 10% of infected women, with a high risk of developing precancerous lesions of the cervix, further leading to cervical cancer. The period involved may extend to 10 to 15 years of detection. Various preventive measures in this process can be the application of standard preventive strategies. The various sexual behavioral practices that are performed by many people arises the possibility that genital HPVs may transmit to breast through oro-genital route or directly through genital-breast contacts, leading to transmission of HPV infection to the area where scrubbed. However, the lack of detection of HPV in breast cancer indicates that the virus has no role to play in breast carcinogenesis in Indian women [49]. In a study conducted by US Armed Forces, it has been found that HPV infections were most frequent, followed by infections associated with Herpes, Chlamydia, Syphilis and Gonorrhea. Along with this, they also compared that women, younger service members, soldiers had higher incidence rates of each STIs.

2.6. Hepatitis B Virus (HBV)

HBV is transmitted by both heterosexual and homosexual mode, which accounts for a majority of the transmission occurring in adult life [50]. However, transmission also occurs through vertical transmission from mother to child during pregnancy and horizontal transmission, which occurs from child to child. In a study conducted by Tandon *et al.* [51], it was estimated that 4% of the population act as a carrier of this infection, out of which 36 million are found to be from India. HBV is reported to be responsible for about 70% of cases of chronic hepatitis and 80% of cases of liver cirrhosis. About 80% of Indian patients with hepato-cellular carcinoma have hepatitis virus associated liver disease [52]. Dual infection of both HIV and HBV can lead to the reactivation of HBV infection and also increase in replication of HIV. A high prevalence of HBV infection has also been reported among individuals practicing risky behaviors and HIV infected individuals [53]. Prevalence of HBV markers was higher in HIV positive subjects compared with HIV negative subjects [54]. It has been stated that countries where HBV infection is known to be endemic, the transmission occurs mostly in childhood through the parenteral route [54].

2.7. Human Immunodeficiency Virus (HIV)

HIV is a lentivirus that causes *Acquired Immunodeficiency Syndrome* (AIDS), a condition in humans in which progressive failure of the immune system allows life-threatening opportunistic infections in human beings. Various routes of infection known to occur are blood transfusion, genital fluid or at times breast milk where mother is infected [55]. Within these bodily fluids, HIV is present as both free virus particles and virus within infected immune cells [55]. HIV weakens the immune system thus making the one more susceptible to infections including all STIs [56]. Two types of HIV are known, HIV-1 and HIV-2. Among these HIV-1 is more virulent and infective [57] and is the cause of the majority of HIV infections worldwide [58].

It has been documented in many studies that ulcerative STIs such as Syphilis, Candidiasis, genital Herpes and Chlamydia increases the heterosexual transmission of HIV infections, by creating susceptible portals for viral entry through genital lesions or chancres [59]. It is known that the concentration of HIV in the mother's blood at the time of delivery determines the risk of neonatal infection [60]. It has also been reported that HIV and HBV are known to share almost same routes of transmission [54]. The other factors like old age, commercial sex work, number of sexual partners during his life time, history of genital ulcer/discharge/warts, and lack of education is the risk determinants of HIV infec-

tion [61]. The results of study done by Arora *et al.* [12] suggests that sexual behavior outside of regular partnerships is a key driver of the HIV epidemic in India.

2.8. Candidiasis

Candidiasis is a most common fungal infection caused by *Candida albicans* [62]. Candidiasis is capable of causing infections that range from superficial systemic and life threatening diseases. Severe Candida infections are also referred to as candidemia and are usually confined to the ones that are immuno compromised either because of AIDS, cancer or transplant [63]. The Vulvovaginal candidiasis is caused by an overgrowth of yeast species named Candida in the vagina and is characterized by curd-like vaginal discharge accompanied with itching and erythema. It is well known that women suffering from candidiasis are more prone to HIV infection and carries a high risk of preterm birth [64]. This is because *C. albicans* produces only mild infections and thus women do not seek treatment. Infection caused by *C. albicans* causes vaginal inflammation that compromise with the integrity of the vaginal mucosa and usually overcome the normal bacterial vaginal flora found in vagina and invades the vaginal epithelium.

2.9. Trichomoniasis

Trichomoniasis is STI caused by the protozoa *Trichomonas vaginalis*. *T. vaginalis* infection is associated with adverse health consequences to both men and women, including infertility, atypical pelvic inflammatory disease [65] and increased HIV transmission [66]. Trichomoniasis is also associated with preterm birth, low-birth-weight infants, predisposition to development of cervical neoplasia in women [67]. Worldwide, 170 million people are infected with *T. vaginalis* every year and out of these 154 million are in resource-limited settings. The incidence of *T. vaginalis* infection occurs more than Chlamydia and Gonorrhea put together. However, this may have been underestimated worldwide since they have been largely based on wet mount microscopy, which has 35% - 82% sensitivity as compared to a more sensitive culture technique or PCR diagnostics [68]. Also, current statistics may not represent the general population, as infection is asymptomatic in at least one-third of women. An alarming fact is the high prevalence of trichomoniasis recorded in otherwise healthy asymptomatic women: one-fifth of asymptomatic women attending family planning clinic in South Africa [69] and 47% in the general population attending an obstetrics and gynecology clinic in India [70]. Hence, trichomoniasis is the most common non-viral STI and has reached the level of a global epidemic.

T. vaginalis is known to be very common STI, how-

ever its prevalence is quite variable. This may be due to the fact that most of the infection caused by this parasite remains asymptomatic [71]. Even if the symptoms are persistent, seems to be generally mild, manifesting a general irritation or infection to the urogenital tract. It is possible that spreading of *T. vaginalis* non-sexually, may also increase the chances of *T. vaginalis* infection in youngsters. *T. vaginalis* is also known to have the ability of survival outside the human body in a wet environment for up to 3 hours. The various complications that may arise due to *T. vaginalis* infection include cervical erosion and premature birth during pregnancy [72]. Furthermore, the parasite can cause infertility in both men and women. Infection with this parasite also increases the risk of acquiring HIV, cervical cancer and aggressive prostate cancer [71,72]. The parasite has the ability to inhabit different host environment that includes urethra, vagina and cervix in women and turn this diverse environment into its nutritional source. Studies in India have shown the prevalence of *T. vaginalis* infection ranged from 1.2% to 28.5% across a variety of populations including obstetrics and gynaecology clinic attendees [73, 74], STI clinic attendees [75], commercial sex workers [76], and community-based populations [77,78]. It has been shown that the ability of *Trichomonas* to undergo genetic change has significant implications for the epidemiology and control of trichomoniasis [79].

3. STIs AFFECTS WOMEN MORE SEVERELY

The pathophysiology of STIs becomes more obvious among women especially with infections of Chlamydia, Candida, *Trichomonas*, Gonorrhea, Hepatitis B, Genital Herpes and HIV. Women may show mild or severe symptoms, however men usually remain asymptomatic [6]. Furthermore, the diagnosis is less sought in men. Though such infections are capable of causing infertility to both men and women at a considerable rate however women are known to be more prone. In addition the transmission of infection from mother to children is also cause serious threat to the neonatal health. Various symptoms recorded in female patients suffering from such infections include vaginal discharge, itching, erythema, PID, preterm birth, recurrent abortions, burning micturition, abdominal pain, discomfort, urethritis, prostatitis etc in both the sexes respectively. Chlamydia and *Trichomonas* are more common in women as compared to men. Women infected with Chlamydia are up to five times more susceptible to acquire HIV infection, if gets a chance to be exposed.

The USPSTF recommends STI screening for the women who engage themselves in high risk sexual behavior. This is because the chances of such infections of

being sexually transmitted increases with increase in number of sexual partners. Other factors include use of condoms for more than one time, having sex under the influence of drugs and alcohol [80]. For instance, the pregnant women suffering from trichomoniasis are found to suffer from preterm rupture of membranes and pre-term labour resulting in a number of adverse pregnancy outcomes like fetal loss at third trimester, neonatal death, low birth weight of the newborn or an infant with reactive serology and clinical symptoms and signs. The extremely high rate of adverse outcomes seen in syphilis is probably due to direct damage caused by the spirochete (*T. Pallidum*) to both the placenta and the umbilical cord, and the damage to both will compromise foetal growth and viability. These women have also traditionally been considered as an important source of transmission of STIs to their sexual partners [81].

The worldwide prevalence of STIs in high-risk groups can vary depending on the geographic origin [82]. Consequently, female infertility is attributed to the tubal factors in about 14% - 38% of such cases [83]. The tubal damage is presumed to be secondary to salpingitis since a two-third of the subjects remains asymptomatic while the remaining third shows symptoms [84,85]. In addition, the recurrence rate of genital herpes appears to be higher in pregnant than in non-pregnant women [86]. The acquisition of genital herpes during pregnancy has been associated with multiple and spontaneous abortions, pre-term labour and congenital herpes [87]. Few studies have proven that females are at a greater risk of acquiring genital herpes from male partners than *vice versa* [88, 89].

Approximately 66% of infected infants from congenital syphilis are asymptomatic at the time of birth and are identified only by routine screening done at clinics. Moreover, the cases of untreated syphilis during pregnancy a transmission rate nearing 100%. Fetal or perinatal death occurs in 40% of affected infants. Infections caused by gonococcal play a disproportionate impact on women health. The lack of diagnosis and treatment, scarce opportunity of medical care, and poor health-care behavior makes the impact of gonococcal infection to be more severe among women in the developing world [90]. Another reason for the highest burden among the young women could be because of the fact that young ones are at greater disadvantage due to the absence of information required for early recognition of the symptoms shown.

4. TREATMENT

The STIs epidemic is predominantly defined within the marginalized communities and their partners. A well known drug, Azithromycin works actively against the major bacterial sexually transmitted pathogens notably,

C. trachomatis, *N. gonorrhoeae* and *T. pallidum*. Azithromycin is an azalide derived from the macrolide class of antibiotics. It offers better oral absorption, better tissue penetration, unique pharmacokinetics and a wider spectrum of antimicrobial activity than erythromycin. It is the recommended treatment for uncomplicated genital infection with *C. trachomatis*. Gastrointestinal side effects of azithromycin have been reported. The viral infections are not curable with antibiotics, however, recurrent herpes manifestations can be suppressed by a few.

The antiviral treatment with aciclovir, famciclovir, and valaciclovir in late pregnancy are all equally beneficial in reducing the duration for appearance of symptoms, the healing time for lesion and viral shedding and preventing the transmission of herpes simplex virus from mother to neonate. Caesarean delivery in women with genital lesions may reduce the risk of transmission and is associated with an increased risk of maternal morbidity and mortality. Oral antiviral treatments effectively decrease symptoms in people with first episodes of genital herpes, however sufficient data is not available to establish which type of oral antiviral drug is most effective. In the cases of recurrent herpes, daily use of valaciclovir reduces the risk of transmission of herpes simplex virus type 2 to an uninfected sexual partner. Cephalosporin based drugs named Cefixime, Ceftriaxone and cefpodoxime are also found to be effective antibiotics for the treatment of *N. gonorrhea*. However, the most recommended treatment regime for *C. trachomatis* includes azithromycin, doxycycline, erythromycin, ofloxacin [91]. Metronidazole is the drug currently licensed for treatment of human trichomoniasis in the United States [92] and is the main drug of choice for treatment of this infection in India as well.

Vaccines are available to protect against some viral STIs, such as Hepatitis B and HPV. Vaccine administration before being sexually active Vaccination before initiation of sexual is advised to assure maximal protection. Two vaccines are available to prevent infection by some HPV types: Gardasil and Cervarix. Both protect against initial infection with HPV “types 16” and “18”, which cause most of the HPV associated cancer cases. The known vaccination Gardasil is also capable of protecting against HPV types 6 and 11, which cause 90% of genital warts. The vaccines may or may not provide benefit to women who are already being infected with HPV types 16 and 18, which is mostly seen in the ones who are sexually active. The use of penicillin in pregnant women with syphilis significantly reduces the risk of stillbirth and preterm delivery [93-96]. Recent studies indicated that without any antimicrobial treatment being provided to women, the maintenance of such infections is known to be indefinite, while men may resolve infection without any treatment [97,98].

5. CONCLUDING REMARKS

The management of a significant proportion of STIs is difficult and complicated because of the reasons that they need a long and tedious course, persistence of infections for years without any major symptoms clinically. For instance, HSV-2 infection has an important role in the spread of HIV infection and increased risk of transmission to new born from infected pregnant women [99]. The most effective way to prevent the transmission of various STIs, other than avoiding sexual contact, is to promote the use of condom during intercourse [4,100] which is equally effective against Gonorrhea, Chlamydia, Trichomonas and Hepatitis B [9]. In order to be more effective, women must be educated about the differences between ulcerative and non-ulcerative types of STIs and the risk of acquiring HIV with each type. The use of condoms in more than 25% of sexual acts by men infected with genital herpes reduces transmission of herpes simplex virus type 2 to their uninfected sexual partners. Other studies have shown that couples tend to use condoms at an early stage of their relationship but once they have enough faith among themselves, the use of such preventive measures decreases [100].

Vaccines are available to protect against some viral STIs, however, vaccination should be administered before initiation of sexual contact to assure maximal protection and from acquiring the STIs. Public health prevention messages should be focused on encouraging individuals to modify or adopt safer sexual practices to reduce the incidence of STIs and HIV.

6. ACKNOWLEDGEMENTS

This work was partially supported by the grants from Department of Biotechnology (BT/PR6301/GBD/27/396/2012) and Department of Science and Technology (File No. SR/FT/LS-117/2011), Government of India, India. MY and RSD are DST young scientist fellows.

REFERENCES

- [1] Jindal, N., Arora, U., Singh, S. and Devi, B. (2012) Prevalence of sexually transmitted infections (HIV, Hepatitis B, Herpes simplex type 2 and Syphilis) among asymptomatic pregnant women. *The Journal of Obstetrics and Gynecology of India*, **62**, 158-161. [doi:10.1007/s13224-012-0164-6](https://doi.org/10.1007/s13224-012-0164-6)
- [2] Donders, G.G. (2000) Treatment of sexually transmitted bacterial diseases in pregnant women. *Drugs*, **59**, 477-485. [doi:10.2165/00003495-200059030-00005](https://doi.org/10.2165/00003495-200059030-00005)
- [3] Hanson, J., Posner, S., Hassig, S., Rice, J. and Farley, T.A. (2005) Assessment of sexually transmitted diseases as risk factors for HIV seroconversion in a New Orleans sexually transmitted disease clinic, 1990-1998. *Annals of Epidemiology*, **15**, 13-20. [doi:10.1016/j.annepidem.2004.05.001](https://doi.org/10.1016/j.annepidem.2004.05.001)
- [4] Risbud, A. (2005) Human immunodeficiency virus (HIV) & sexually transmitted diseases (STDs). *Indian Journal of Medical Research*, **121**, 369-376.
- [5] Singhal, P., Naswa, S. and Marfatia, Y.S. (2009) Pregnancy and sexually transmitted viral infections. *Indian Journal of Sexually Transmitted Diseases*, **30**, 71-78. [doi:10.4103/0253-7184.62761](https://doi.org/10.4103/0253-7184.62761)
- [6] Paavonen, J. and Eggert-Kruse, W. (1999) Chlamydia trachomatis: Impact on human reproduction. *Human Reproduction Update*, **5**, 433-447. [doi:10.1093/humupd/5.5.433](https://doi.org/10.1093/humupd/5.5.433)
- [7] Chakravarti, A., Rawat, D. and Jain, M. (2005) A study on the perinatal transmission of the hepatitis B virus. *Indian Journal of Medical Microbiology*, **23**, 128-130. [doi:10.4103/0255-0857.16055](https://doi.org/10.4103/0255-0857.16055)
- [8] Einwalter, L.A., Ritchie, J.M., Ault, K.A. and Smith, E.M. (2005) Gonorrhea and chlamydia infection among women visiting family planning clinics: Racial variation in prevalence and predictors. *Perspectives on Sexual and Reproductive Health*, **37**, 135-140. [doi:10.1363/3713505](https://doi.org/10.1363/3713505)
- [9] Sayegh, M.A., Fortenberry, J.D., Anderson, J. and Orr, D.P. (2005) Relationship quality, coital frequency, and condom use as predictors of incident genital Chlamydia trachomatis infection among adolescent women. *Journal of Adolescent Health*, **37**, 163. [doi:10.1016/j.jadohealth.2004.08.018](https://doi.org/10.1016/j.jadohealth.2004.08.018)
- [10] Bell, D.C., Mosier, V. and Atkinson, J.S. (2003) Protecting oneself from human immunodeficiency virus: Are prevention messages being heard? *Clinical Infectious Diseases*, **37**, S433-S438. [doi:10.1086/377544](https://doi.org/10.1086/377544)
- [11] Manhart, L.E. and Koutsky, L.A. (2002) Do condoms prevent genital HPV infection, external genital warts, or cervical neoplasia? A meta-analysis. *Sexually Transmitted Diseases*, **29**, 725-735. [doi:10.1097/00007435-200211000-00018](https://doi.org/10.1097/00007435-200211000-00018)
- [12] Arora, P., Nagelkerke, N.J. and Jha, P. (2012) A systematic review and meta-analysis of risk factors for sexual transmission of HIV in India. *PLoS One*, **7**, e44094. [doi:10.1371/journal.pone.0044094](https://doi.org/10.1371/journal.pone.0044094)
- [13] Gerbase, A.C., Rowley, J.T. and Mertens, T.E. (1998) Global epidemiology of sexually transmitted diseases. *Lancet*, **351**, 2-4. [doi:10.1016/S0140-6736\(98\)90001-0](https://doi.org/10.1016/S0140-6736(98)90001-0)
- [14] Brunham, R.C., Paavonen, J., Stevens, C.E., Kiviat, N., Kuo, C.C., Critchlow, C.W. and Holmes, K.K. (1984) Mucopurulent cervicitis—The ignored counterpart in women of urethritis in men. *The New England Journal of Medicine*, **311**, 1-6. [doi:10.1056/NEJM198407053110101](https://doi.org/10.1056/NEJM198407053110101)
- [15] Stamm, W.E., Wagner, K.F., Amsel, R., Alexander, E.R., Turck, M., Counts, G.W. and Holmes, K.K. (1980) Causes of the acute urethral syndrome in women. *The New England Journal of Medicine*, **303**, 409-415. [doi:10.1056/NEJM198008213030801](https://doi.org/10.1056/NEJM198008213030801)
- [16] Mardh, P.A., Ripa, T., Svensson, L. and Westrom, L. (1977) Chlamydia trachomatis infection in patients with acute salpingitis. *The New England Journal of Medicine*, **296**, 1377-1379. [doi:10.1056/NEJM197706162962403](https://doi.org/10.1056/NEJM197706162962403)
- [17] Hillis, S.D., Owens, L.M., Marchbanks, P.A., Amsterdam, L.F. and Mac Kenzie, W.R. (1997) Recurrent chlamydial infections increase the risks of hospitalization for ectopic

- pregnancy and pelvic inflammatory disease. *American Journal of Obstetrics & Gynecology*, **176**, 103-107. doi:10.1016/S0002-9378(97)80020-8
- [18] Beem, M.O. and Saxon, E.M. (1977) Respiratory-tract colonization and a distinctive pneumonia syndrome in infants infected with *Chlamydia trachomatis*. *The New England Journal of Medicine*, **296**, 306-310. doi:10.1056/NEJM197702102960604
- [19] Gravett, M.G., Nelson, H.P., DeRouen, T., Critchlow, C., Eschenbach, D.A. and Holmes, K.K. (1986) Independent associations of bacterial vaginosis and *Chlamydia trachomatis* infection with adverse pregnancy outcome. *JAMA*, **256**, 1899-1903. doi:10.1001/jama.1986.03380140069024
- [20] Gencay, M., Koskiniemi, M., Saikku, P., Puolakkainen, M., Raivio, K., Koskela, P. and Vaheri, A. (1995) *Chlamydia trachomatis* seropositivity during pregnancy is associated with perinatal complications. *Clinical Infectious Diseases*, **21**, 424-426. doi:10.1093/cid/cir698
- [21] Geisler, W.M. (2011) Diagnosis and management of uncomplicated *Chlamydia trachomatis* infections in adolescents and adults: summary of evidence reviewed for the 2010 centers for disease control and prevention sexually transmitted diseases treatment guidelines. *Clinical Infectious Diseases*, **53**, S92-S98. doi:10.1093/cid/cir698
- [22] Smith, K.J., Hamza, S. and Skelton, H. (2004) Topical imidazoquinoline therapy of cutaneous squamous cell carcinoma polarizes lymphoid and monocyte/macrophage populations to a Th1 and M1 cytokine pattern. *Clinical and Experimental Dermatology*, **29**, 505-512. doi:10.1111/j.1365-2230.2004.01593.x
- [23] Bhatla, N., Puri, K., Joseph, E., Kriplani, A., Iyer, V.K. and Sreenivas, V. (2013) Association of *Chlamydia trachomatis* infection with human papillomavirus (HPV) & cervical intraepithelial neoplasia: A pilot study. *Indian Journal of Medical Research*, **137**, 533-539.
- [24] Singh, V., Gupta, M.M., Satyanarayana, L., Parashari, A., Sehgal, A., Chattopadhyay, D. and Sodhani, P. (1995) Association between reproductive tract infections and cervical inflammatory epithelial changes. *Sexually Transmitted Infections*, **22**, 25-30. doi:10.1097/00007435-199501000-00005
- [25] Surana, A., Rastogi, V. and Nirwan, P.S. (2012) Association of the serum anti-chlamydial antibodies with tubal infertility. *Journal of Clinical and Diagnostic Research*, **6**, 1692-1694.
- [26] Knapp, J.S., Neal, S.W., Parekh, M.C. and Rice, R.J. (1995) *In vitro* activity of a new fluoroquinolone, CP-99, 219, against strains of *Neisseria gonorrhoeae*. *Antimicrobial Agents and Chemotherapy*, **39**, 987-989. doi:10.1128/AAC.39.4.987
- [27] Barry, P.M. and Klausner, J.D. (2009) The use of cephalosporins for gonorrhea: The impending problem of resistance. *Expert Opinion on Pharmacotherapy*, **10**, 555-577. doi:10.1517/14656560902731993
- [28] Kent, M.E., Arora, A., Owen, P.J. and Khanduja, V. (2010) Assessment and correction of femoral malrotation following intramedullary nailing of the femur. *Acta Orthopaedica Belgica*, **76**, 580-584.
- [29] Stamm, L.V. (2010) Global challenge of antibiotic-resistant *Treponema pallidum*. *Antimicrobial Agents and Chemotherapy*, **54**, 583-589. doi:10.1128/AAC.01095-09
- [30] Weinstock, H., Berman, S. and Cates Jr., W. (2004) Sexually transmitted diseases among American youth: Incidence and prevalence estimates, 2000. *Perspectives on Sexual and Reproductive Health*, **36**, 6-10. doi:10.1363/3600604
- [31] Calonge, N. (2004) Screening for syphilis infection: Recommendation statement. *Annals of Family Medicine*, **2**, 362-365. doi:10.1370/afm.215
- [32] Schmid, G.P., Stoner, B.P., Hawkes, S. and Broutet, N. (2007) The need and plan for global elimination of congenital syphilis. *Sexually Transmitted Diseases*, **34**, S5-10. doi:10.1097/01.olq.0000261456.09797.1b
- [33] Lou, Y., Qesmi, R., Wang, Q., Steben, M., Wu, J. and Hefernan, J.M. (2012) Epidemiological impact of a genital herpes type 2 vaccine for young females. *PLoS One*, **7**, e46027. doi:10.1371/journal.pone.0046027
- [34] Benedetti, J., Corey, L. and Ashley, R. (1994) Recurrence rates in genital herpes after symptomatic first-episode infection. *Annals of Internal Medicine*, **121**, 847-854. doi:10.7326/0003-4819-121-11-199412010-00004
- [35] Mertz, G.J., Schmidt, O., Jourden, J.L., Guinan, M.E., Remington, M.L., Fahnlander, A., Winter, C., Holmes, K.K. and Corey, L. (1985) Frequency of acquisition of first-episode genital infection with herpes simplex virus from symptomatic and asymptomatic source contacts. *Sexually Transmitted Diseases*, **12**, 33-39. doi:10.1097/00007435-198501000-00007
- [36] Whitley, R.J., Kimberlin, D.W. and Roizman, B. (1998) Herpes simplex viruses. *Clinical Infectious Diseases*, **26**, 541-553. doi:10.1086/514600
- [37] Wald, A. and Link, K. (2002) Risk of human immunodeficiency virus infection in herpes simplex virus type 2-seropositive persons: A meta-analysis. *The Journal of Infectious Diseases*, **185**, 45-52. doi:10.1086/338231
- [38] Fleming, D.T., McQuillan, G.M., Johnson, R.E., Nahmias, A.J., Aral, S.O., Lee, F.K. and St Louis, M.E. (1997) Herpes simplex virus type 2 in the United States, 1976 to 1994. *The New England Journal of Medicine*, **337**, 1105-1111. doi:10.1056/NEJM199710163371601
- [39] Xu, F., Sternberg, M.R., Kottiri, B.J., McQuillan, G.M., Lee, F.K., Nahmias, A.J., Berman, S.M. and Markowitz, L.E., (2006) Trends in herpes simplex virus type 1 and type 2 seroprevalence in the United States. *JAMA*, **296**, 964-973. doi:10.1001/jama.296.8.964
- [40] Nahmias, A.J., Lee, F.K. and Beckman-Nahmias, S., (1990) Sero-epidemiological and -sociological patterns of herpes simplex virus infection in the world. *Scandinavian Journal of Infectious Diseases*, **69**, 19-36.
- [41] Chayavichitsilp, P., Buckwalter, J.V., Krakowski, A.C. and Friedlander, S.F. (2009) Herpes simplex. *Pediatrics in Review*, **30**, 119-129. doi:10.1542/pir.30-4-119
- [42] Looker, K.J., Garnett, G.P. and Schmid, G.P. (2008) An estimate of the global prevalence and incidence of herpes simplex virus type 2 infection. *Bulletin of the World Health Organization*, **86**, 805-812.

- [doi:10.2471/BLT.07.046128](https://doi.org/10.2471/BLT.07.046128)
- [43] Bharadwaj, M. Hussain, S. and Nasare, V. Das B.C. (2009) HPV & HPV vaccination: Issues in developing countries. *Indian Journal of Medical Research*, **130**, 327-333.
- [44] Schiffman, M. and Kjaer, S.K. (2003) Chapter 2: Natural history of anogenital human papillomavirus infection and neoplasia. *JNCI Monographs*, **31**, 14-19.
- [45] Walboomers, J.M., Jacobs, M.V., Manos, M.M., Bosch, F.X., Kummer, J.A., Shah, K.V., Snijders, P.J., Peto, J., Meijer, C.J. and Munoz, N. (1999) Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *The Journal of Pathology*, **189**, 12-19. [doi:10.1002/\(SICI\)1096-9896\(199909\)189:1<12::AID-PA TH431>3.0.CO;2-F](https://doi.org/10.1002/(SICI)1096-9896(199909)189:1<12::AID-PA TH431>3.0.CO;2-F)
- [46] D'Souza, G., Kreimer, A.R., Viscidi, R., Pawlita, M., Fakhry, C., Koch, W.M., Westra, W.H. and Gillison, M.L. (2007) Case-control study of human papillomavirus and oropharyngeal cancer. *The New England Journal of Medicine*, **356**, 1944-1956. [doi:10.1056/NEJMoa065497](https://doi.org/10.1056/NEJMoa065497)
- [47] Ault, K.A. (2006) Epidemiology and natural history of human papillomavirus infections in the female genital tract. *Infectious Diseases in Obstetrics and Gynecology*, **2006**, 40470. [doi:10.1155/IDOG/2006/40470](https://doi.org/10.1155/IDOG/2006/40470)
- [48] Goldstein, M.A., Herzog, D.B., Misra, M. and Sagar, P. (2008) Case records of the Massachusetts General Hospital. Case 29-2008. A 19-year-old man with weight loss and abdominal pain. *The New England Journal of Medicine*, **359**, 1272-1283. [doi:10.1056/NEJMcpr0804641](https://doi.org/10.1056/NEJMcpr0804641)
- [49] Das, B.C. Bharti, A.C. and Bharadwaj, M. (2009) Human papillomavirus & cervical cancer: Looking ahead. *Indian Journal of Medical Research*, **130**, 210-211.
- [50] Kane, M.A. (1993) Progress on the control of hepatitis B infection through immunisation. *Gut*, **34**, S10-S12. [doi:10.1136/gut.34.2_Suppl.S10](https://doi.org/10.1136/gut.34.2_Suppl.S10)
- [51] Tandon, B.N. (1995) HBV control in India. *Indian Journal of Pediatrics*, **62**, 669-671. [doi:10.1007/BF02825112](https://doi.org/10.1007/BF02825112)
- [52] Dhir, V.K. (1997) New approach to laboratory diagnosis. *Africa Health*, **20**, 18.
- [53] Kura, M.M., Hira, S., Kohli, M., Dalal, P.J., Ramnani, V.K. and Jagtap, M.R. (1998) High occurrence of HBV among STD clinic attenders in Bombay, India. *International Journal of STD & AIDS*, **9**, 231-233. [doi:10.1258/0956462981921954](https://doi.org/10.1258/0956462981921954)
- [54] Risbud, A., Mehendale, S., Basu, S., Kulkarni, S., Walimbe, A., Arankalle, V., Gangakhedkar, R., Divekar, A., Bollinger, R., Gadkari, D. and Paranjape, R. (2002) Prevalence and incidence of hepatitis B virus infection in STD clinic attendees in Pune, India. *Sexually Transmitted Infections*, **78**, 169-173. [doi:10.1136/sti.78.3.169](https://doi.org/10.1136/sti.78.3.169)
- [55] Douek, D.C., Roederer, M. and Koup, R.A. (2009) Emerging concepts in the immunopathogenesis of AIDS. *Annual Review of Medicine*, **60**, 471-484. [doi:10.1146/annurev.med.60.041807.123549](https://doi.org/10.1146/annurev.med.60.041807.123549)
- [56] Zetola, N.M. and Klausner, J.D. (2007) Syphilis and HIV infection: An update. *Clinical Infectious Diseases*, **44**, 1222-1228. [doi:10.1086/513427](https://doi.org/10.1086/513427)
- [57] Gilbert, P.B., McKeague, I.W., Eisen, G., Mullins, C., Gueye-NDiaye, A., Mboup, S. and Kanki, P.J. (2003) Comparison of HIV-1 and HIV-2 infectivity from a prospective cohort study in Senegal. *Statistics in Medicine*, **22**, 573-593. [doi:10.1002/sim.1342](https://doi.org/10.1002/sim.1342)
- [58] Reeves, J.D. and Doms, R.W. (2002) Human immunodeficiency virus type 2. *Journal of General Virology*, **83**, 1253-1265.
- [59] Lazzarin, A., Saracco, A., Musicco, M. and Nicolosi, A. (1991) Man-to-woman sexual transmission of the human immunodeficiency virus. Risk factors related to sexual behavior, man's infectiousness, and woman's susceptibility. Italian Study Group on HIV Heterosexual Transmission. *Archives of Internal Medicine*, **151**, 2411-2416. [doi:10.1001/archinte.1991.00400120055009](https://doi.org/10.1001/archinte.1991.00400120055009)
- [60] Thea, D.M., Steketee, R.W., Pliner, V., Bornschlegel, K., Brown, T., Orloff, S., Matheson, P.B., Abrams, E.J., Bamji, M., Lambert, G., Schoenbaum, E.A., Thomas, P.A., Heagarty, M. and Kalish, M.L. (1997) The effect of maternal viral load on the risk of perinatal transmission of HIV-1. New York City Perinatal HIV Transmission Collaborative Study Group. *AIDS*, **11**, 437-444. [doi:10.1097/00002030-199704000-00006](https://doi.org/10.1097/00002030-199704000-00006)
- [61] Mehendale, S.M., Shepherd, M.E., Divekar, A.D., Gangakhedkar, R.R., Kamble, S.S., Menon, P.A., Yadav, R., Risbud, A.R., Paranjape, R.S., Gadkari, D.A., Quinn, T.C., Bollinger, R.C. and Rodrigues, J.J. (1996) Evidence for high prevalence & rapid transmission of HIV among individuals attending STD clinics in Pune, India. *Indian Journal of Medical Research*, **104**, 327-335.
- [62] Walsh, T.J. and Dixon, D.M. (1996) Spectrum of Mycoses. In: *Medical Microbiology*, 4th Edition, University of Texas Medical Branch, Galveston.
- [63] Kourkoumpetis, T., Manolaki, D., Velmahos, G., Chang, Y., Alam, H.B., De Moya, M.M., Sailhamer, E.A. and Mylonakis, E. (2010) Candida infection and colonization among non-trauma emergency surgery patients. *Virulence*, **1**, 359-366. [doi:10.4161/viru.1.5.12795](https://doi.org/10.4161/viru.1.5.12795)
- [64] Lubelchek, R.J., Kroc, K.A., Levine, D.L., Beavis, K.G. and Roberts, R.R. (2011) Routine, rapid HIV testing of medicine service admissions in the emergency department. *Annals of Emergency Medicine*, **58**, S65-S70. [doi:10.1016/j.annemergmed.2011.03.027](https://doi.org/10.1016/j.annemergmed.2011.03.027)
- [65] Moodley, P., Wilkinson, D., Connolly, C., Moodley, J. and Sturm, A.W. (2002) *Trichomonas vaginalis* is associated with pelvic inflammatory disease in women infected with human immunodeficiency virus. *Clinical Infectious Diseases*, **34**, 519-522. [doi:10.1086/338399](https://doi.org/10.1086/338399)
- [66] Sorvillo, F., Smith, L., Kerndt, P. and Ash, L. (2001) *Trichomonas vaginalis*, HIV, and African-Americans. *Emerging Infectious Diseases*, **7**, 927-932. [doi:10.3201/eid0706.010603](https://doi.org/10.3201/eid0706.010603)
- [67] Viikki, M., Pukkala, E., Nieminen, P. and Hakama, M. (2000) Gynaecological infections as risk determinants of subsequent cervical neoplasia. *Acta Oncologica*, **39**, 71-75. [doi:10.1080/028418600431003](https://doi.org/10.1080/028418600431003)
- [68] Shafir, S.C., Sorvillo, F.J. and Smith, L. (2009) Current issues and considerations regarding trichomoniasis and human immunodeficiency virus in African-Americans. *Clinical Microbiology Reviews*, **22**, 37-45.

[doi:10.1128/CMR.00002-08](https://doi.org/10.1128/CMR.00002-08)

- [69] Johnson, L.F., Coetzee, D.J. and Dorrington, R.E. (2005) Sentinel surveillance of sexually transmitted infections in South Africa: A review. *Sexually Transmitted Infections*, **81**, 287-293. [doi:10.1136/sti.2004.013904](https://doi.org/10.1136/sti.2004.013904)
- [70] Yadav, M., Gupta, I. and Malla, N. (2005) Kinetics of immunoglobulin G, M, A and IgG subclass responses in experimental intravaginal trichomoniasis: Prominence of IgG1 response. *Parasite Immunology*, **27**, 461-467. [doi:10.1111/j.1365-3024.2005.00800.x](https://doi.org/10.1111/j.1365-3024.2005.00800.x)
- [71] Soper, D. (2004) Trichomoniasis: Under control or undercontrolled? *American Journal of Obstetrics & Gynecology*, **190**, 281-290. [doi:10.1016/j.ajog.2003.08.023](https://doi.org/10.1016/j.ajog.2003.08.023)
- [72] Petrin, D., Delgaty, K., Bhatt, R. and Garber, G. (1998) Clinical and microbiological aspects of *Trichomonas vaginalis*. *Clinical Microbiology Reviews*, **11**, 300-317.
- [73] Yadav, M., Dubey, M.L., Gupta, I., Bhatti, G. and Malla, N. (2007) Cysteine proteinase 30 in clinical isolates of *T. vaginalis* from symptomatic and asymptomatic infected women. *Experimental Parasitology*, **116**, 399-406. [doi:10.1016/j.exppara.2007.02.007](https://doi.org/10.1016/j.exppara.2007.02.007)
- [74] Sharma, A.K., Ranjan, R. and Mehta, G. (2004) Prevalence and determinants of reproductive tract infections among women. *Journal of Communicable Diseases*, **36**, 93-99.
- [75] Divekar, A.A., Gogate, A.S., Shivkar, L.K., Gogate, S. and Badhwar, V.R. (2000) Disease prevalence in women attending the STD clinic in Mumbai (formerly Bombay), India. *International Journal of STD & AIDS*, **11**, 45-48. [doi:10.1258/0956462001914896](https://doi.org/10.1258/0956462001914896)
- [76] Das, A., Jana, S., Chakraborty, A.K., Khodakevich, L., Chakraborty, M.S. and Pal, N.K. (1994) Community based survey of STD/HIV infection among commercial sex-workers in Calcutta (India). Part-III: Clinical findings of sexually transmitted diseases (STD). *Journal of Communicable Diseases*, **26**, 192-196.
- [77] Patel, V., Weiss, H.A., Mabey, D., West, B., D'Souza, S., Patil, V., Nevrekar, P., Gupte, S. and Kirkwood, B.R. (2006) The burden and determinants of reproductive tract infections in India: A population based study of women in Goa, India. *Sexually Transmitted Infections*, **82**, 243-249.
- [78] Rathore, M., Vyas, L. and Bhardwaj, A.K. (2007) Prevalence of reproductive tract infections amongst ever married women and sociocultural factors associated with it. *Journal of the Indian Medical Association*, **105**, 71-78.
- [79] Conrad, M.D., Gorman, A.W., Schillinger, J.A., Fiori, P.L., Arroyo, R., Malla, N., Dubey, M.L., Gonzalez, J., Blank, S., Secor, W.E. and Carlton, J.M. (2012) Extensive genetic diversity, unique population structure and evidence of genetic exchange in the sexually transmitted parasite *Trichomonas vaginalis*. *PLoS Neglected Tropical Diseases*, **6**, e1573.
- [80] Santelli, J.S., Robin, L., Brener, N.D. and Lowry, R. (2001) Timing of alcohol and other drug use and sexual risk behaviors among unmarried adolescents and young adults. *Family Planning Perspectives*, **33**, 200-205. [doi:10.2307/2673782](https://doi.org/10.2307/2673782)
- [81] Folch, C., Esteve, A., Sanclemente, C., Martro, E., Lugo, R., Molinos, S., Gonzalez, V., Ausina, V. and Casabona, J. (2008) Prevalence of human immunodeficiency virus, *Chlamydia trachomatis*, and *Neisseria gonorrhoeae* and risk factors for sexually transmitted infections among immigrant female sex workers in Catalonia, Spain. *Sexually Transmitted Diseases*, **35**, 178-183. [doi:10.1097/OLQ.0b013e31815a848d](https://doi.org/10.1097/OLQ.0b013e31815a848d)
- [82] Vall-Mayans, M., Villa, M., Saravanya, M., Loureiro, E., Merono, M., Arellano, E., Sanz, B., Saladie, P., Andreu, A. and Codina, M.G. (2007) Sexually transmitted *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and HIV-1 infections in two at-risk populations in Barcelona: Female street prostitutes and STI clinic attendees. *International Journal of Infectious Diseases*, **11**, 115-122. [doi:10.1016/j.ijid.2005.11.005](https://doi.org/10.1016/j.ijid.2005.11.005)
- [83] Cates Jr. W. (1987) Tubal infertility: An ounce of (more specific) prevention. *JAMA*, **257**, 2480. [doi:10.1001/jama.1987.03390180098032](https://doi.org/10.1001/jama.1987.03390180098032)
- [84] Sellors, J.W., Mahony, J.B., Chernesky, M.A. and Rath, D.J. (1988) Tubal factor infertility: An association with prior chlamydial infection and asymptomatic salpingitis. *Fertility and Sterility*, **49**, 451-457.
- [85] Westrom, L. (1985) Influence of sexually transmitted diseases on sterility and ectopic pregnancy. *Acta Europaea Fertilitatis*, **16**, 21-24.
- [86] Brown, Z.A., Vontver, L.A., Benedetti, J., Critchlow, C.W., Hickok, D.E., Sells, C.J., Berry, S. and Corey, L. (1985) Genital herpes in pregnancy: Risk factors associated with recurrences and asymptomatic viral shedding. *American Journal of Obstetrics & Gynecology*, **153**, 24-30.
- [87] Brown, Z.A., Selke, S., Zeh, J., Kopelman, J., Maslow, A., Ashley, R.L., Watts, D.H., Berry, S., Herd, M. and Corey, L. (1997) The acquisition of herpes simplex virus during pregnancy. *The New England Journal of Medicine*, **337**, 509-515. [doi:10.1056/NEJM199708213370801](https://doi.org/10.1056/NEJM199708213370801)
- [88] Fleming, D.T., McQuillan, G.M., Johnson, R.E., Nahmias, A.J., Aral, S.O., Lee, F.K. and St Louis, M.E. (1997) Herpes simplex virus type 2 in the United States, 1976 to 1994. *The New England Journal of Medicine*, **337**, 1105-1111. [doi:10.1056/NEJM199710163371601](https://doi.org/10.1056/NEJM199710163371601)
- [89] Mertz, G.J., Schmidt, O., Jourden, J.L., Guinan, M.E., Remington, M.L., Fahnlander, A., Winter, C., Holmes, K.K. and Corey, L. (1985) Frequency of acquisition of first-episode genital infection with herpes simplex virus from symptomatic and asymptomatic source contacts. *Sexually Transmitted Diseases*, **12**, 33-39.
- [90] Wilkinson, D. (1999) Public-private health sector partnerships for STD control in developing countries: Perspectives from experience in rural South Africa. *Sexually Transmitted Infections*, **75**, 285.
- [91] Stamm, L.V. (2010) Global challenge of antibiotic-resistant *Treponema pallidum*. *Antimicrobial Agents and Chemotherapy*, **54**, 583-589. [doi:10.1128/AAC.01095-09](https://doi.org/10.1128/AAC.01095-09)
- [92] Snipes, L.J., Gamard, P.M., Narcisi, E.M., Beard, C.B., Lehmann, T. and Secor, W.E. (2000) Molecular epidemiology of metronidazole resistance in a population of *Trichomonas vaginalis* clinical isolates. *Journal of Clinical Microbiology*, **38**, 3004-3009.

- [93] Menezes, E.V., Yakoob, M.Y., Soomro, T., Haws, R.A., Darmstadt, G.L. and Bhutta, Z.A. (2009) Reducing stillbirths: Prevention and management of medical disorders and infections during pregnancy. *BMC Pregnancy and Childbirth*, **9**, S4. [doi:10.1186/1471-2393-9-S1-S4](https://doi.org/10.1186/1471-2393-9-S1-S4)
- [94] Barros, F.C., Bhutta, Z.A., Batra, M., Hansen, T.N., Victora, C.G. and Rubens, C.E. (2010) Global report on preterm birth and stillbirth (3 of 7): Evidence for effectiveness of interventions. *BMC Pregnancy and Childbirth*, **10**, S3. [doi:10.1186/1471-2393-10-S1-S3](https://doi.org/10.1186/1471-2393-10-S1-S3)
- [95] Blencowe, H., Cousens, S., Kamb, M., Berman, S. and Lawn, J.E. (2010) Lives saved tool supplement detection and treatment of syphilis in pregnancy to reduce syphilis related stillbirths and neonatal mortality. *BMC Public Health*, **11**, S9. [doi:10.1186/1471-2458-11-S3-S9](https://doi.org/10.1186/1471-2458-11-S3-S9)
- [96] Hawkes, S., Matin, N., Broutet, N. and Low, N. (2011) Effectiveness of interventions to improve screening for syphilis in pregnancy: A systematic review and meta-analysis. *The Lancet Infectious Diseases*, **11**, 684-691. [doi:10.1016/S1473-3099\(11\)70104-9](https://doi.org/10.1016/S1473-3099(11)70104-9)
- [97] Cudmore, S.L. and Garber, G.E. (2010) Prevention or treatment: The benefits of *Trichomonas vaginalis* vaccine. *Journal of Infection and Public Health*, **3**, 47-53. [doi:10.1016/j.jiph.2010.01.003](https://doi.org/10.1016/j.jiph.2010.01.003)
- [98] Van Der Pol, B., Williams, J.A., Orr, D.P., Batteiger, B.E. and Fortenberry, J.D. (2005) Prevalence, incidence, natural history, and response to treatment of *Trichomonas vaginalis* infection among adolescent women. *The Journal of Infectious Diseases*, **192**, 2039-2044. [doi:10.1086/498217](https://doi.org/10.1086/498217)
- [99] Chen, K.T., Segu, M., Lumey, L.H., Kuhn, L., Carter, R.J., Bulterys, M. and Abrams, E.J. (2005) Genital herpes simplex virus infection and perinatal transmission of human immunodeficiency virus. *Obstetrics & Gynecology*, **106**, 1341-1348. [doi:10.1097/01.AOG.0000185917.90004.7c](https://doi.org/10.1097/01.AOG.0000185917.90004.7c)
- [100] Bell, D.C., Mosier, V. and Atkinson, J.S. (2003) Protecting oneself from human immunodeficiency virus: Are prevention messages being heard? *Clinical Infectious Diseases*, **37**, S433-S438. [doi:10.1086/377544](https://doi.org/10.1086/377544)