Learning Objectives
1. Review the epidemiology of sexually Transmitted Diseases
2. Assess the personal risk factors and community factors that contribute to STD morbidity
3. Describe the epidemiology of the most common STDs

Overview
- 20 million incident cases per year (CDC, 2015)
- $16-17 billion medical costs (CDC, 2015)
- More than 25 organisms
  - Most common
    - Neisseria gonorrhoea
    - Chlamydia trachomatis
    - Treponema pallidum
    - Hemophilus ducreyi (canchroid)
    - Trichomonas vaginalis (bacterial vaginitis)
    - Chronic viral infections
      - Herpes, human papillomavirus, HBV, HCV, HIV

*Chlamydia trachomatis* includes three human biovars (a variant strain):
1. Serovars Ab, B, Ba, or C — cause trachoma: infection of the eyes, which can lead to blindness
2. Serovars D-K — cause urethritis, pelvic inflammatory disease, ectopic pregnancy, neonatal pneumonia, and neonatal conjunctivitis
3. Serovars L1, L2 and L3 — lymphogranuloma venereum (LGV)
**Definition**

- STDs are diseases transmitted through sexual intercourse—a sexual contact which includes vaginal, oral, or rectal intercourse
  - Heterosexual or homosexual sex
  - Risk may be dependent upon specific activities
  - Receptive rectal and vaginal intercourse are the highest risk activities
- Dependent upon behavioral factors
Determinants of STD Transmission

- Probability of coming into contact with an STD-infected partner
- Susceptibility of the host—generally universal
- Efficiency of the transmission
Epidemiology
- Incidence is highest in adolescents and young adults
- >95% of gonorrhea and Chlamydia cases occur between ages 15 and 39
- Highest rates in women ages 15-19 and men ages 20-24
- Correlated with multiple sexual partners, high risk partner

Risk factors for STDs
- Age at first intercourse
- Number of partners
  - Serial monogamy vs. multiple concurrent partners
- Use of barrier contraceptives, e.g., condoms
- Other comorbidities
  - Drug use, Low SES, Commercial sex work, Risk of exposure while travelling in areas with endemic STDs (incidental or purposeful)

Assessment of sexual behavior
- Cross-sectional surveys
  - Rates of adolescent premarital intercourse
    • 1970-1988 White 27% Black 46%
    • 1988 White 51% Black 59%
  - Rates of condom use
    • 1988 <50%
    • More recent 75%
  - CDC Survey 1995-1997 (YRFSS)
    • Sexual activity 48% to 53%
    • 16% have 4 or more partners
    • 57% used condom in last intercourse
Impact of SES on STDs

- Higher rates of STDs in impoverished areas—sex as a means of ‘earning’
- Increased rate of STDs
  - Decrease in preventive services
  - Increase in fees for services
  - Urbanization in developing countries
    - Men work in cities, frequent sex workers, give spouses STDs (STDs in sub-Saharan Africa)
    - Illicit drug use
    - Increased STDs among minorities

Gonorrhea

- Caused by Neisseria gonorrhoeae, a gram negative diplococcus
- Symptoms
  - Men—discharge and dysuria within one week; 5-10% asymptomatic
  - Women—cervicitis, which if untreated can cause PID
  - Average Rate is 110/10^5 pop since 1997
Gonorrhea (...continued/2)
- 2014 there were 350,062 cases
- Decreasing incidence of 70% from the peak in mid-70s
- Estimated 1-2 cases per reported case
- Disease of poverty especially among African-Americans in the inner city
- Rates are 5-10 times higher among all adolescents, and 30-50 times higher among African-American adolescents
- SC ranks 3rd in GC incidence in USA

Pelvic Inflammatory Disease (PID)
- Lack of prospective studies
- Occurs in approximately 30% of women with untreated gonorrhea
- In 1988 estimated 500,000 cases, 200,000 hospitalizations
- Increased risk of ectopic pregnancy, infertility; RR=10 cf. women w/o PID
- Overall direct economic impact of PID ~4.2 billion
Perinatal disease
- Rare in US but more common in developing countries
- Can cause blindness
- Prevention is with antibiotic cream at delivery
- Untreated infants have a 42% incidence of gonococcal opthalmia
Gonorrhea (...continued/4)

- Diagnosis — culture
- Treatment single dose oral regimens
  - ciprofloxacin, ofloxacin, or cefixime
  - need concurrent treatment for chlamydia
- Prior to 1980s penicillin was the drug of choice, now penicillin resistance is so common it is no longer used

Control strategies

- Partner notification very ineffective
  - Short incubation period (2-5 days)
- Screening strategies, especially among women have been utilized
- Current urine screening test

Chlamydiiasis

- Most common bacterial STD in the US
- 4 million cases annually
- Symptoms similar to gonorrhea but less acute, incubation 7-14 days
  - Most common lesion in men urethritis, epididymitis; >30% asymptomatic
  - Women cervical infection, endometritis, 50% asymptomatic, untreated 30% develop PID
Chlamydia (...continued/2)

- Reported infection more common in women
  - Rate 233.7/10^5;  Rate 610.6/10^5
  - Rates have increased since 1984
  - Results from increased screening and reporting
  - 1985 fewer than 10 states required reporting, now it is 40 states
  - Difficulty in identifying trends
  - SC has the 2nd highest incidence rate after DC

- Risk factors
  - Multiple partners, new partner, low SES, young age, poor predictive value and only identify 1/3 of cases
Chlamydia (…continued/3)

- Leads to premature rupture of membrane (PROM) and pre-term labor and delivery
- Impact of screening
  - Initial decrease in prevalence among tested
  - Followed by 50% over 4 subsequent years
  - Due to removal of infected individuals
- Lab diagnosis was difficult until the advent of Nucleic Acid Amplification Test (NAAT)

Syphilis

- Cause by bacterium
- Three clinical stages
  - Primary
  - Secondary
  - Late (tertiary and late benign syphilis)
- Latent syphilis
  - Inapparent symptoms
  - Early (<1 year) and late (> 1 year)
Epidemiology of Syphilis

- **Risk factors**
  - Multiple sex partners
    - Bath houses, crack epidemic
  - Predominately in minority communities, especially in the South
  - 1996, N=11,387 cases (lowest number)

Changing epidemiology of Syphilis

- Since WW II, steady decline
- 1976-81 50% increase predominately among gay white men; equated to # of Gay Bathhouse
- 1981-84 large decrease, >90% among gay men
- 1984-89 >100% increase in minority heterosexual transmission
- Male:Female ratio changed from 4:1 to 1:1
- 1989-1990 large increase in congenital syphilis
- Trends have decreases since then except for Baltimore and a variety of counties in the Southeast
In the US, incidence in gay white men is approximated by the number of Gay Bathhouse in the community

**Clinical course of syphilis**
- Infection with *Treponema pallidium* with sexual contact involving a mucousal membrane
- Incubation period 10-30 days
- Transmission is relatively inefficient
  - 20% per sexual contact
- Latency period of 3 weeks prior to symptoms
  - Non-infectious
  - Antibiotic use will prevent transmission
  - Widely used to control the spread of syphilis

**Clinical course of syphilis (...2)**
- Development of initial genital ulcerative lesion (chancre)
  - Painless
  - Patient becomes infectious
  - Systemic disease even in primary syphilis
    - 10-15% have cerebral spinal fluid abnormalities
    - Concern for patients with HIV
    - Left untreated, chancre will heal within 2-3 weeks
Clinical course of syphilis (...3)
- If untreated 4-8 weeks, secondary syphilis develops
  - Systemic vasculitis with high levels of *T. Pallidium* in the blood
  - Dermatological symptoms
    - Palmar or plantar rash, alopecia, mucousal lesions
  - Resolves within 1-2 months of onset

Clinical course of syphilis (4)
- Late complications
  - Develop 10-20 years after early syphilis
  - Earlier with patients with HIV infection
  - Neurosyphilis, cardiovascular syphilis

Congenital syphilis
- Vertical transmission rate is 75-95%
  - Increased stillbirth rates
  - Clinical syndromes at birth
    - Bone abnormalities
- Transmission occurs transplacentally
  - Screening during 1st and 3rd trimester
  - Treatment during pregnancy
  - Considered a sentinel event
  - Risk factors
    - No prenatal care, crack cocaine use
  - Difficult to diagnose in newborn due to passively acquired maternal antibody
**Treatment**
- Primary, secondary, early latent
  - Benzathine penicillin, doxycycline
- Late latent syphilis
  - Higher dose, IM

**Intervention**
- After treatment, patient is non-infectious
- Long latency offers opportunity to reduce secondary spread
  - Partner notification and screening
  - Presumptive treatment of partners
- Inexpensive test allows widespread screening
- Treatment during pregnancy prevents vertical transmission
  - Establishment of screening and treatment programs

**Chancroid**
- Genital ulcer disease
- Caused by *Haemophilus ducreyi*
- Primarily seen in developing countries and subtropical areas of developed world
- Associated with prostitution and illicit drug use
- Difficult to diagnose, sensitivity 80%
- Incubation 4-7 days
- Painful ulcer, no systemic disease or vertical transmission
Genital Herpes

Genital Herpes infection
- Life-long infection, latency and recurrences
- Almost exclusively sexually transmitted
  - 90% HSV-2
  - 10% HSV-1
- Acute infection follows inoculation of the virus to mucosal site

Epidemiology of chancroid
- Most common genital ulcer disease in developing countries
- US, epidemics of heterosexual transmission but no homosexual epidemics
- Related to travel to endemic countries
- Prevention is difficult
  - Difficulty in diagnosis
  - Aggressive partner notification and presumptive TX
Clinical features of herpes

- Primary - Ulceration develops 5-10 days after exposure
  - Systemic signs, fever, myalgia, headache
  - Often asymptomatic
- Recurrent – May develop at any time after primary
  - Prodrome, tingling or itching
- Clinical first episode vs. first clinical episode of recurrent disease
  - Many have serologic evidence of prior infection

Clinical features of herpes (2)

- Symptomatic recurrences
  - Less symptomatic and heal faster than primary episode
  - Recurrences more frequent within the first year
- Risk factors for recurrence
  - Not well defined, physical and psychologic stress
- Asymptomatic shedding
  - Major role in transmission
  - Occurs about 1% of the time
  - Increased with HIV
  - Impact of control strategies

Epidemiology of herpes

- Widely prevalent in the adult population
  - Approximately 1 in 6 of married sexually active Americans (40 million) is infected
  - Difficult to enumerate
  - First-office visits used as a surrogate
    Increasing since 1970s
  - Higher rates in African Americans
Herpes simplex in pregnancy

- Problem if lesions are present in the birth canal at the time of delivery
- Routine culture at parturition
  - If positive, infant can be started on prophylactic antiviral therapy
- Major risk factor is developing primary herpes during the last trimester
  - 33% neonatal herpes syndrome – fatal or leads to disability
- Caesarian section used to prevent transmission if viral shedding is present

Treatment of herpes

- Acyclovir (Zovirax)
  - More rapid healing, decreases viral shedding
  - Not curative
- Suppressive therapy
  - Individuals with more than 6 recurrences per year, HIV
  - >90% effective

Intervention strategies

- Factors associated with increased transmission
  - Asymptomatic viral shedding
  - Misclassification
  - 11% transmission per year among monogamous partners
  - Independent risk factor for HIV transmission
Human Papillomavirus (HPV)
- RNA virus, more than 80 subtypes
- Majority of infections are asymptomatic
- 3 month incubation period
- Small proportion will develop genital warts (1% of sexually active US population)
- Associated with the development of epithelial cancer
  - Cervical cancer most common
  - Focus is on preventing cancer not HPV infection

Genital Warts for HPV
- Condylomata acuminata
- Condylomata lata (Primary syphilis)

Cervical HPV Infection & Genital
"Yes, oral sex can lead to oral cancer", Michael Douglas
This type of cancer has risen 225 percent in the last two decades
HPV causes
- 83-95% of the anal cancers
- 20-50% of the vulvar cancers
- 60-65% of the vaginal cancers
- 30-42% of the penile cancers
- ~ 40% of the oral cancers in oral sex

HPV types 16 and 18 are most common carcinogenic HPV

HPV 16 and 18 are the most common carcinogenic HPV.

PAP smears for Cx Ca Dx

Long latency and slow progression of cervical cancer
- Screening is effective
- Recommendations every 3 years
- If abnormalities are identified
  • Colposcopy or biopsy

Vaginal infections

Trichomonas
- 3 million women annually
- Large number of asymptomatic patients
- Treatment with metronidazole
  • May be used during pregnancy
- Can contribute to PROM in pregnancy
Vaginal infections (2)
- Bacterial vaginosis
  - Secondary disorder
    • Results from other cervical infections
    • Secondary to antibiotic use
    • Douching
  - Treated with antibiotics, recurrence common
  - More common in sexually active women but no infection has been identified in men
  - Risk factor for PROM

Control of STDs
- Many STDs are associated with HIV transmission
- Based on reproductive rate
- $R_0 = \beta CD$
  - $\beta =$ transmission coefficient
  - $C =$ turnover of partners
    • Number of different partners
    • Number of exposures with each partner
  - $D =$ duration of infection

Intervention strategies
- Promoting condom use
- Partner notification
- Screening
- Core group targeting
  - Social networks
  - GIS screening
Condoms and STDs

- June 2000 NIH/CDC/USAID convened a workshop to evaluate male latex condoms and STDs
- Overall recommendations:
  - Abstinence and long term mutually monogamous relationships are the best ways to prevent STDs
  - Latex condoms can reduce the rate of STDs but are not 100% effective

Epidemiological challenges in determining condom effectiveness

- Studies involve private behavior
- Difficult to determine the level of STD exposure
- Often employ a retrospective design
- Design a study that would be effective in determining real life effectiveness of condoms in preventing an STD.

Condoms and STDs

- Two types of transmission
  - Infected semen or vaginal fluids contact mucosal surfaces
    - Discharge diseases: HIV, gonorrhea, chlamydia, trichomoniasis
  - Primarily transmitted through contact with infected skin or mucosal surfaces
    - Genital ulcer diseases: genital herpes, syphilis, chancroid, HPV
HIV/AIDS
- Most deadly STD
- More comprehensive research on effectiveness of condoms in preventing HIV/AIDS
- Lab data shows condoms provide an impermeable barrier to particles the size of STDs
- Theoretical basis prevents exposure to semen and vaginal fluids
- Epi studies: one partner infected and the other not show a high degree of protection

Discharge diseases
- Lab studies: impermeable barrier
- Theoretical: physical properties of condoms provide a barrier to genital secretions
- Epi studies: Inconsistent results. Many studies were not well designed to answer this question and more research is needed

Genital Ulcer disease and HPV
- Infections can occur in both male and female areas that are and are not covered by condom. Can reduce the risk of herpes, syphilis and chancroid only when the infected area or site of potential exposure is protected.
- Condom use has been associated with a lower rate of cervical cancer.
Genital Ulcer disease & HPV (2)
- Lab studies: Latex condoms provide an impermeable barrier to particles the size of STDs
- Theoretical basis: Depends upon the site of the sore/ulcer or infection. Consistent and correct use would protect against some but not all transmissions

Genital Ulcer disease & HPV (3)
- Epi studies: Inconsistent findings. No conclusive studies have specifically addressed the transmission of chancroid and condom use. Although several studies have found reduced rate of genital ulcers in settings where chancroid is a leading cause of genital ulcers.

Genital Ulcer disease & HPV (4)
- Inconsistent findings of condoms and HPV
- HPV infection is intermittently detected
  Association between condom use and HPV-associated diseases: genital warts, cervical dysplasia, and cervical cancer.
- Reasons are unknown. Co-infections with other STDs increase the chance that HPV will lead to cancer. More research is needed.