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Factors Associated with Chlamydia trachomatis Reinfection Among Puerto Rican Adolescents 2008-2012

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This is to certify that the doctoral dissertation by

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Abstract

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by

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MT, Interamerican University of Puerto Rico, 1998

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The purpose of this study was to investigate the association between *Chlamydia trachomatis* reinfection rates of Puerto Rican adolescents and failure to follow the retesting protocol, failure of sexual partners to receive treatment, and failure to participate in the sexual orientation program about risk factors. Secondary data analysis, from a historical prospective study from the Health Department of Puerto Rico, was used in this study. Data analysis was restricted to adolescents 15 to 19-years-old who had a positive chlamydia result and reinfection pattern since January 2008 through December 2012. Multiple logistic regression analyses were run to predict *Chlamydia trachomatis* reinfection. Results showed a statistically significant association association between *Chlamydia trachomatis* reinfection and not having followed the retesting protocol (*OR*=1.243, 95% *CI* 1.089-2.930, *p*-value 0.038). A statistically significant association association was found between *Chlamydia trachomatis* reinfection and sexual partners having not received treatment (*OR*=1.713, 95% *CI* 0.761-2.024, *p*-value 0.029). A statistically significant association was found between *Chlamydia trachomatis* reinfection and having not participated in the Puerto Rico Department of Health's sexual orientation program (*OR*=1.243, 95% *CI* 0.762-2.026, *p*-value 0.034).

The contribution to social change is identifying factors significantly associated with *Chlamydia trachomatis* reinfection. Study findings provide useful guidance for clinicians and public health professionals on how to reduce *Chlamydia trachomatis* reinfection rates among at risk Puerto Rican adolescents.

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Dedication

I want to dedicate this dissertation to my children, Fabian and Andrea Abrante-Rosado, for being the reason of my life.

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I want to acknowledge the assistance provided by the Department of Health of Puerto Rico. I want to thank Ms. Bessie Lopez and Mr. Jose Colon who were invaluable in the data acquisition.

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Chapter 1: Introduction to the Study

Sexually transmitted diseases (STDs) are a group of transmissible diseases that are acquired by sexual contact. *Chlamydia trachomatis* is the most common sexually transmitted bacterium producing over 3 million new cases yearly in United States and Europe (Oakeshott et al., 2010). Infections produced by chlamydia remain asymptomatic and may go undiagnosed and untreated. The infection in women can result in pelvic inflammatory disease, causing infertility, severe pelvic pain and ectopic pregnancy. Chlamydia is responsible for up to 55% of the chronic urethritis in men. Individuals aged 20- to 24-years-old have the highest rates of chlamydia infection, followed by adolescents aged 15 to 19 (Center for Disease Control and Prevention [CDC], 2008). In Puerto Rico in 2008, the age-adjusted rate for females 15 to 19 was 1,219.0 and the rate for males was 96.5. However, in 2009, the total number of chlamydia cases increased in Puerto Rico, with an age adjusted rate of 1,277.5 in females 15 to 19 and 124.8 for males. In 2010, chlamydia age-adjusted rates were as follows: in females 15 to 19, 1,059.0 and for males were 146.1. In 2011, chlamydia age-adjusted rates were the following: females 15 to 19, 1,027 and for males were 132.5. In 2012, the total number of chlamydia cases increased, with an age-adjusted rate of 1,048.7 in females 15 to 19 and 575.2 for males (Department of Health of Puerto Rico, 2013).

The World Health Organization (WHO; 2005) indicated that sexually active youth aged 10-20 years constitute a critical period due to the transition to emotional and maturity to sexual behaviors. Sexually active young adolescents ages 15 to 19 and young adults ages 20 to 24 are experiencing the highest STD rates of chlamydia infections in the

United States and territories. According to DiClemente, Salazar, and Crosby (2007), left untreated, STD infections may produce serious complications including cervical cancer, infertility, or death.

Table 1 shows that the group with the highest incidence of *chlamydia trachomatis* is the group ages 20 -24, followed by the group of adolescents ages 15-19. The following table shows age-adjusted rate, gender, and incidence per 100,000 habitants of the same age and gender in years since 2008 through 2012 in Puerto Rico.

Table 1

Chlamydia Trachomatis. Adjusted Rate per Age and Gender in Puerto Rico, 2008-2012

	2008		2009		2010		2011		2012	
Group	Age adjusted rate		Age adjusted rate		Age adjusted rate		Age adjusted rate		Age adjusted rate	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
10-14	2.6	49.4	3.9	51.7	0.8	34.5	0.7	34.3	1.5	25.1
15-19	96.5	1,219.0	133.8	1,396.5	146.1	1,059.0	132.5	1,027.2	119.4	1,048.7
20-24	225.3	1,585.2	293.2	1,074.3	311.5	1,491.1	337.7	1,441.6	346.9	1,651.9
25-29	119.2	745.1	169.9	829.1	174.5	543.6	209.1	583.7	212.5	656.9
30-34	33.9	304.2	48.2	309.5	81.3	189.7	85.2	195.4	98.6	228.1
35-39	14.6	129.5	22.8	112.6	42.5	66.4	55.2	85.4	44.0	109.3
40-44	14.0	51.6	12.3	45.4	14.4	28.9	21.8	35.3	23.5	29.1
45-54	6.1	20.3	11.1	26.6	11.5	13.2	11.1	9.6	14.6	17.2
55-64	2.0	9.3	3.6	3.8	4.9	3.3	4.0	5.0	4.4	6.7
65+	0.4	1.7	0.9	3.1	3.0	2.3	0.8	0.7	2.5	2.3

Note. Source: Department of Health of Puerto Rico (2013).

Chlamydia trachomatis infection is treated on site. A single dose of Azythromycin 1g is given to those positive cases. To control disease transmission and/or reinfection, patients treated for chlamydia should avoid sexual intercourse for at least 7 days after the initial prophylaxis. To control the risk of reinfection, sexual partners are contacted to also be treated (CDC, 2010c).

Background

Chlamydia trachomatis is the most common sexually transmitted bacteria (Gottlieb et al., 2010). Repeated infections and coinfections have been found to be common after treatment. The main reasons for reinfection include failure of sexual partners to receive treatment and unprotected sexual intercourse with new sexual partners (Heijne, Althaus, Herzog, Kretzschmar, & Low, 2010). Coinfections with other STDs are a concern (Marangoni et al., 2012). According to the CDC (2010c), the most common coinfections in United States and Puerto Rico include gonorrhea, syphilis, human papilloma virus (venereal warts), and HIV. In Puerto Rico, chlamydial reinfection and coinfection have increased in the age group of 15-19, (CDC, 2010c). Even when gonorrhea has declined, chlamydia coinfection with gonorrhea has a high prevalence among infected people (14.5%; CDC, 2010c).

Chlamydia coinfects with HIV (CDC, 2010c). According to Joyee, Thyagarajan, Reddy, Venkatesan, and Ganapathy (2005), HIV coinfection with chlamydia is high and requires a routine screening for chlamydia and interventions to reduce the spreading of STDs. Chlamydia infection is mainly asymptomatic and under diagnosed, contributing to the spread of other STDs. Chlamydia infection facilitates the susceptibility, acquisition, and transmission of other STDs up to five fold (Nusbaum, Wallace, Slatt, & Kondrad, 2004). Sexually transmitted infections have shown to influence the transmission of HIV since STIs inhibit the lactic acid produced by Lactobacillus, predominant bacterium found in vaginal secretions. The inhibition of the lactic acid may enhance the transmission of the antigens associated with HIV (Cone, 2014).

STD costs are increasing in Puerto Rico yearly (Department of Health of Puerto Rico, 2013). *Chlamydia trachomatis* is the most common bacterium that is sexually transmitted. Based on the high incidence of chlamydia, the Department of Health of Puerto Rico considered testing and treating chlamydia infection for wedding purposes. Law no. 133 of 1937, which was changed, established that all persons getting married must undergo the *Treponema pallidum,* or syphilis test, in order to obtain a wedding license (LexJuris of Puerto Rico, 2007).

A chlamydia reinfection pattern has been observed when a sexual partner failed to receive treatment (CDC, 2010c). As stated by the STD treatment guidelines from the Health Department of Puerto Rico (2006, 2010) and CDC (2006a, 2010c), a follow-up treatment is recommended to test all recently infected patients. Women and men should visit the STDs clinics after 1 month after initial treatment for retest. It is also recommended that patients receive a follow up after 3 months, even when sexual partners have not received treatment.

Problem Statement

Chlamydia trachomatis is a bacterium that causes genital infections. It produces cervicitis and urethritis in women and produces urethritis in men (Trelle, Shang, Nartey, Cassell, & Low, 2007). Virulent strains are found to cause rectal and pharyngeal infections; these strains are transmitted during labor and can cause pneumonia and eye infections in infants. Strains L1, L2, and L3 cause lymphogranuloma venereum, a severe inguinal infection that primarily infects the lymphatic nodes (Blank, Schillinger, & Harbatkin, 2005). The majority of the individuals infected are asymptomatic. Around 20

to 30% of the patients infected develop inguinal lymphadenopathy, which can progress to a severe inguinal obstruction causing elephantiasis (Ginige, Fairley, Hocking, Bowden, & Chen, 2007).

About 30% of untreated cervical chlamydiosis resulted in pelvic inflammatory disease within a few weeks of infection. Approximately 20 to 25 % of those women with pelvic inflammatory disease that become pregnant will have an ectopic pregnancy or become infertile (Molano et al., 2005). About 50% of chlamydia infections resolve spontaneously without treatment. However, reinfections occur easily, particularly when sexual partners refuse to be treated (Simms, Warburton, & Westrom, 2003).

According to the Department of Health of Puerto Rico (2010), *Chlamydia trachomatis* is the most common STD found in adolescents ages 15 to 19. Chlamydia diagnoses occur more frequently in women because they visit physicians more frequently than men. During gynecological visits, women are screened routinely to detect STDs to reduce the risk of complications (Ginige et al., 2007).

Reinfection patterns among Puerto Rican adolescents are very limited. There is a lack of statistical analysis and information in Puerto Rico regarding the risk factors associated with reinfection in this population. I investigated the risk factors associated with chlamydia reinfection among Puerto Rican adolescents using secondary data analysis from 2008 through 2012.

Nature of the Study

I conducted a secondary analysis of existing data within the 2008-2012 timeframe. These data were collected under the STD MIS software program of the Health

Department of Puerto Rico. The target population included adolescents aged 15 to 19 years old who tested positive for *Chlamydia trachomatis* during the years of 2008 through 2012. The purpose of this study was to investigate the association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy, failure of sexual partners to receive treatment and to follow the retesting protocol, and failure to participate in the program offered by the Health Department of sexual orientation about risk factors during chlamydia treatment. Data access included if the patient received antibiotic therapy and participated in the retesting protocol, if there was documentation of notification and treatment of sexual partners, if the patient participated in the sexual orientation program about risk factors offered by the Health Department; and patient risk history with two or more sex partners during chlamydia treatment, if the patient had new sex partners during chlamydia treatment, and the patient used a condom. The methodology and research design will be discussed in Chapter 3 of this study.

Research Questions and Hypotheses

Research Question 1. Is the high rate of *Chlamydia trachomatis* reinfection outcomes in Puerto Rican adolescents associated with failure to receive antibiotic therapy and to follow the retesting protocol established by the health department?

$H1_0$: There will not be a significant association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy and to follow the retesting protocol established by the health department.

$H1_A$: There will be a significant association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy and to follow the retesting protocol established by the health department.

Research Question 2. Is *Chlamydia trachomatis* reinfection outcome in Puerto Rican adolescents associated with gaps in notification and screening sexual partners for infection?

$H2_0$: There will not be a significant association between *Chlamydia trachomatis* reinfection and failure of sexual partners to receive treatment.

$H2_A$: There will be a significant association between *Chlamydia trachomatis* reinfection and failure of sexual partners to receive treatment.

Research Question 3. Is *Chlamydia trachomatis* reinfection in Puerto Rican adolescents associated with participation in the program of sexual orientation about risk factors offered by the health department during chlamydia treatment?

$H3_0$: There will not be a significant association between reinfection with participation in the program of sexual orientation about risk factors offered by the health department during chlamydia treatment.

$H3_A$: There will not be a significant association between reinfection with participation in the program of sexual orientation about risk factors offered by the health department during chlamydia treatment.

Purpose

The purpose of this study was to conduct a secondary data analysis to evaluate risk factors associated with chlamydia reinfection among Puerto Rican adolescents aged

15 to 19 years. Predictors to study were postperiodic and follow-up treatment, notification and screening of sexual partners, and participation in the sexual education program about risk factors offered by the health department.

Epidemiological Conceptual Model

Historically, adolescents have some common antecedents prior to having multiple sexual partners or outcomes that are associated with a sexual risk behavior. High risk behaviors include a lack of parental monitoring, community factors, school orientation, poverty, socioeconomic level, impulsivity, perception of the risk of infection, and self-esteem (DiClemente et al., 2007).

If *Chlamydia trachomatis* is left untreated, it may cause pelvic inflammatory disease, which may result in infertility, severe pelvic pain, and ectopic pregnancy. Chlamydia also enhances the susceptibility of coinfections including gonorrhea, *trichomonas vaginalis*, genital warts, and HIV (Molano et al., 2005; Novak & Karlsson, 2006). Chlamydia exposure increases the probability of HIV infection (Joyee et al., 2005). According to Advocates for Youth (2008), Puerto Rico had the top 10 highest incidence of HIV cases in 2004. However, the infection often remains asymptomatic; hence, it is often undiagnosed and untreated. The highest incidence of chlamydia is reported in young adolescents ages 15 to 19 (DiClemente et al., 2007).

According to the CDC (2012), only 38% of 60,000 men and women who had a positive chlamydia screening between 2007 and 2009 participated in an Infertility and Prevention Project in New York, New Jersey, and the U.S. Virgin Islands. They were retested after 30 days posttreatment. The CDC found that retesting is critical to avoid the

spreading of chlamydia and other STDs. In order to reduce *Chlamydia trachomatis* infections, it is necessary to screen sexual partners and improve antibiotic treatment to reduce reinfections (Batteiger et al., 2010). The goal of this study was to reduce *Chlamydia trachomatis* reinfection and associated adverse sequellae.

Definitions

Adolescents: A person aged 15 to 19 years of age who is physiologically immature that reflects psychological and intellectual immaturity (US Department of Health and Human Services, 2007).

Azithromycin: An antibiotic that is used to treat bacterial infections that can cause throat infections, skin infections, urethral, cervical, or genital ulcers and middle ear infections (Physician Desk Reference [PDR], 2010).

Behavioral change: A modification strategy that seeks to extinguish or inhibit an undesirable behavior to a desired behavior (DiClemente et al., 2007).

Chlamydia: A common bacterium capable of producing genital infections. The infection may result in chronic urethritis, epididymitis, cervicitis, and acute salpingitis. (CDC, 2010c).

Coinfection: When an infection is produced by two or more pathogens simultaneously, a coinfection is produced. The most common coinfection with *Chlamydia trachomatis* is frequently found among patients who have gonococcal infection (CDC, 2010c). Coinfection was not considered in this study.

Follow up treatment and retesting program: The CDC recommended follow up after 3 to 4 weeks, 3 months, and 12 months after completing therapy to evaluate if the person is cured, for new symptoms, and if reinfection is suspected (CDC, 2010c).

Genital herpes: Condition caused by *Herpes Simplex Virus* that produces a painful genital lesion (CDC, 2006a).

Genital warts: An infection produced by *Human Papilloma Virus* in the external genitalia or perianal region. The disease is associated with the development of cancer (CDC, 2006b).

Gonorrhea: A sexually transmitted bacterium capable of producing urethritis, epididymitis, or salpingitis (CDC, 2006b).

Initially infected: The first infection developed by any STD, which is transmitted by sexual contact (CDC, 2010c).

Notification and screening sexual partners: The CDC recommended referring sexual partners for evaluation and treatment if infection is suspected. Antibiotic therapy can be delivered with the patient as chlamydia reinfection is associated with failure in sexual partners' notification (CDC, 2010c).

Prevention program: An approach used to anticipate social, physical, and environmental precautions to avoid side effects (DiClemente et al., 2007).

Sexual education: The process of training about sexual discipline that requires knowledge skills, education, and character about the sexual components (US Department of Health and Human Services, 2007).

Reinfection: Reinfection occurs when, after treatment, an infection repeats. *Chlamydia trachomatis* reinfection occurs because untreated sexual partners may have different sexual partnerships (CDC, 2010c).

Sexually transmitted diseases (STDs): A group of diseases that spread by having intimate sexual intercourse with someone who has the disease (US Department of Health and Human Services, 2007).

Syphilis: A complex infection caused by the bacteria *Treponema pallidum*. The infection has three stages (primary, secondary, and tertiary). Most of the time, primary and secondary syphilis are asymptomatic. Clinical problems occur in the tertiary stage where the central nervous system results impacted with neurosyphilis (CDC, 2006c).

Assumptions

Researchers have been reviewing *Chlamydia trachomatis* reinfection based on behavioral intervention programs and notification and treatment of sexual partners (Batteiger et al., 2010; Hwang, Tebb, Shafer, & Plantell, 2005). Assumptions of this research include the following:

- Chlamydia is the most common sexually transmitted infection found in the United States, its territories, and Europe (Oakeshott et al., 2010).
- This bacterium may produce serious complications including infertility, ectopic pregnancy, cervical cancer, or death (Molano et al., 2005).
- Adolescents are the most exposed group to *Chlamydia trachomatis* in the United States. Familiar environment, parental monitoring, community, psychological states, self-esteem, and societal factors need attention. It is

important to educate adolescents and to help them to develop behavioral modifications toward sexuality (DiClemente et al., 2007).

- *Chlamydia trachomatis* reinfection in adolescents mostly occurs because, even when they receive appropriate therapy, their sexual partners do not receive treatment (Batteiger et al., 2010; Hwang et al., 2005).

Limitations

This research was limited existing data that were gathered from the STD MIS software program of the Health Department of Puerto Rico. I collected data from adolescents aged 15-19 who tested positive to *Chlamydia trachomatis* between January 2008 and December 2012. Patterns of reinfection, antibiotic therapy, notification, and treatment of sexual partners, screening for reinfections, and participation in the program of sexual education about risk factors offered by the Health Department were considered for the purpose of this study.

Delimitations

Data provided were exclusively from adolescents who visited the public health clinics of the Health Department of Puerto Rico. Data did not contain information about private physicians or any other treatment.

Significance of the Study

The CDC (2010c) recommended that patients need to be instructed to contact their sexual partners in order to receive evaluation, counseling, testing, and treatment for any STD. Failure to receive treatment is related to a high risk of coinfection and HIV. It

is important to receive a follow-up antibiotic treatment with counseling about STDs to avoid recurrence (CDC, 2010c).

Implications for Social Change

Researchers have been designing programs to achieve significant sexual behavioral change. Interventions have targeted individuals for positive attitudes toward abstinence, condom use, and self efficacy to motivate adolescents to seek behavioral change. According to Robin et al. (2004), interventions have achieved significant sexual behavior and outcome. Pedlow and Carey (2003) demonstrated that unprotected sex can be reduced up to 75%, condom use can improve up to 53%, and sustained new preventive behavioral methods can be achieved.

This study may lead to positive social change by is identifying the necessity to reduce *Chlamydia trachomatis* transmission based on follow-up treatment of sexual partners and counseling about sexual behavior to prevent reinfection, morbidity, and mortality associated with other STDs.

Summary

Chlamydia trachomatis is the most common sexually transmitted bacteria (Gottlieb et al., 2010). Repeated infections and coinfections have been found to be common after treatment. The purpose of this study was to conduct a secondary data analysis to evaluate risk factors associated with chlamydia reinfection among Puerto Rican adolescents aged 15 to 19 years. I conducted a secondary analysis of existing data within the 2008-2012 timeframe.

Chapter 2 of this research include the literature on *Chlamydia trachomatis* reinfection patterns, notification and treatment of sexual partners, behavioral interventions, and risk reduction program need in order to reduce *Chlamydia trachomatis* infections among Puerto Rican adolescents. Chapter 3 is an explanation of the methods used to gather and interpret the data. Chapter 4 is a report of the data and Chapter 5 is the interpretation of those data.

Chapter 2: Literature Review

Introduction

Chlamydia trachomatis is an obligate intracellular bacterium that produces genital tract infections in women and men. It is the most common STI reported in the world (Gottlieb et al., 2010). Chlamydia is reaching epidemic rates because most of the time it is asymptomatic and humans are reluctant to address sexual behavioral issues and outcomes (Gottlieb et al., 2010). All communities are impacted by chlamydia and all individuals are impacted for the costs associated by this disease (Weinstock, Berman, & Cates, 2004). The annual treating includes chlamydia infections and PID produced by it, which reaches $10 billion. *C. trachomatis* has become a public health problem that needs attention and a genuine solution because over 3 million people are infected in the United States each year (Weinstock et al., 2004).

C. trachomatis is the most common sexually bacterial infection in the world (Gottlieb et al., 2010). It is capable of infecting the genital organs of women and men. Generally, the infection does not produce symptoms or can produce mild symptoms (Trelle et al., 2007). As a silent condition it can produce serious and irreversible complications. Chlamydia has become a public health problem since many cases cannot be reported because most of the people do not know they are infected with chlamydia. It is estimated that 2 million people in the United States and territories are infected without symptoms (Oakeshott et al., 2010). Reinfection occurs easily if the partners do not receive treatment (DiClemente et al., 2007). Chlamydia prevalence and incidence is higher in individuals 16 to 19 years old (Rekart & Brunham, 2008).

This chapter is a review of literature related to *C. trachomatis* incidence, clinical consequences, economic evaluation, and the benefit of a risk reduction program. The literature review is based on argued presentations published in peer reviewed journals about *chlamydia, risk reduction programs,* and *behavioral interventions.* Primary source information was performed using EBSCO database, Medline, Medscape and Pub Med, and summary publications produced by such authoritative sources as the World Health Organization, the USPHS's CDC, and the Department of Health of Puerto Rico.

Natural History of *Chlamydia trachomatis*

C. trachomatis is an obligate intracellular pathogen, living only inside human cells (Carlson et al., 2008). *C. trachomatis* is a gram negative bacterium that includes three human serotypes (A, B, C) producing trachoma (eye infection), serotypes (D-K) producing urethritis, and serotypes (L1, L2 and L3) producing lymphogranuloma venereum (Carlson et al., 2008). Chlamydia presents intracytoplasmic inclusions within the human cell that infect the host nucleus (Carlson et al., 2008). This bacterium was first isolated from embryonated eggs in 1957. In this isolation it was confirmed that chlamydia is not able to synthesize its own ATP (Trentmann, Horn, van Scheltinga, & Haferkamp, 2007). Chlamydia requires the human cell for reproduction and virulence. The developmental life cycle is unique in this bacterium.

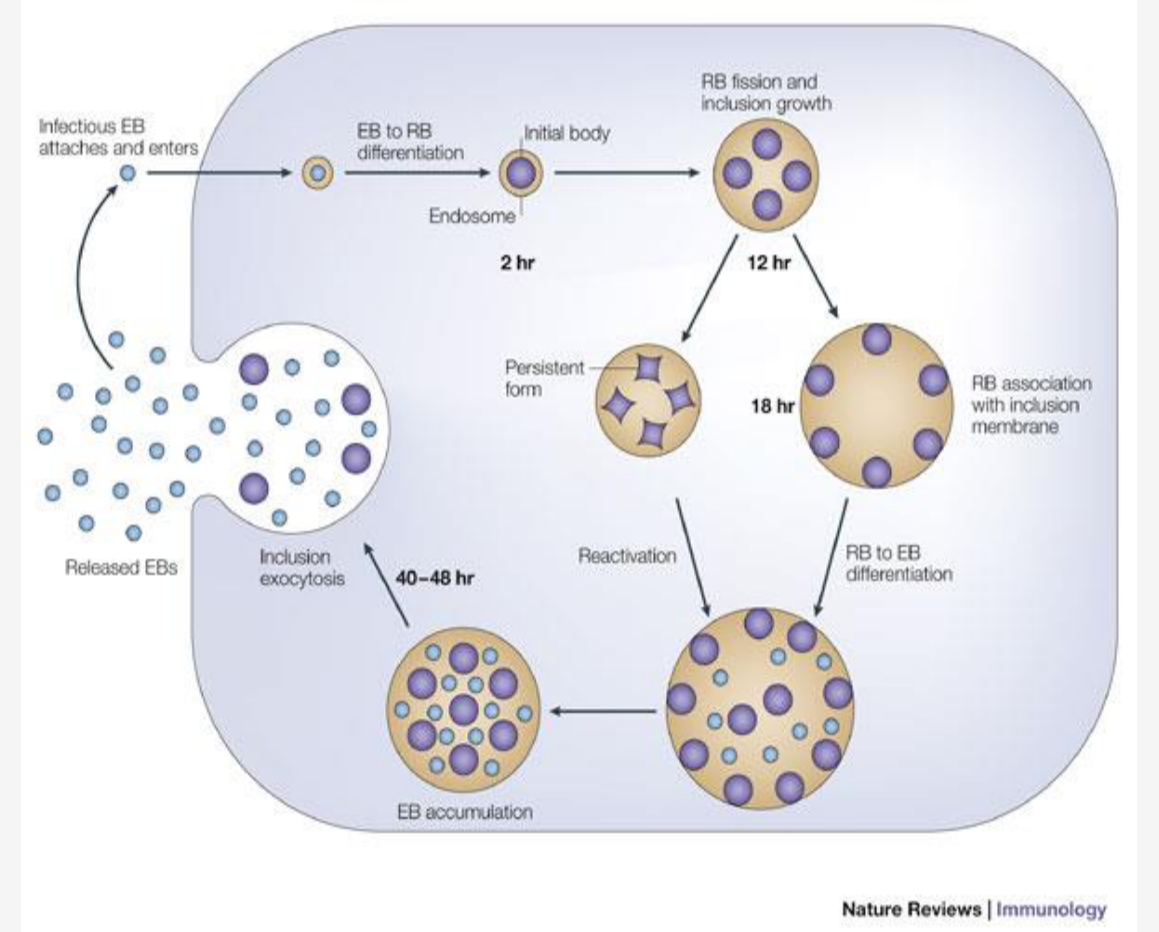


Figure 1. The developmental cycle of *Chlamydia trachomatis*. Reprinted by permission from Macmillan Publishers Ltd: *Nature Reviews Immunology*, *5*, 149-161, copyright 2005, Source from Brunham & Ladino.

C. trachomatis is an obligate intracellular pathogen, infecting only humans, contains two stages for developmental life cycle. The first stage is the infectious elementary body (EB) that attaches and enters the human epithelial cells through the membrane (Brunham & Ladino, 2005). After entering the human cell, the EB produces a vacuole that helps it to create the habitat for the replication. Then after 12 hours the EB is transformed into an active reticulate body (RB) which starts reproduction by binary fission (Brunham & Ladino, 2005). After 40 to 48 hours the RB is differentiated again

into 100 to 1,000 EB, which are released from the vacuole capable to infect other cells (Brunham & Ladino, 2005).

Symptoms may vary; 75% of women and 25% of men do not present symptoms at all. In women, symptoms are presenting with an increased vaginal discharge with burning sensation during urination, irritability in the vaginal area, may produce bleeding after sexual intercourse, and abdominal pain (Novak & Karlsson, 2006). Most of the time, the infection starts at the cervix area. In men, the infection starts as a non gonococcal urethritis, which is the main symptom (Novak & Karlsson, 2006). This includes a yellowish discharge, burning sensation during urination and pain (Novak & Karlsson, 2006).

Another infection produced by *C. trachomatis* is lymphogranuloma venereum, characterized by swelling of the lymph nodes. This disease produced proctitis in men and rectal narrowing in women (Molano et al., 2005). During its primary stage small ulcers are detected in the groin area. In the secondary stage, ulcers start a suppurative lymphadenopathy, named a bubo that produces fever and generalized arthralgia. During the tertiary stage, rectal complications occur (Molano et al., 2005).

The majority of the STD cases worldwide are caused by *C. trachomatis* producing a public health problem concern (Rekart & Brunham, 2008). Commonly, it produces an asymptomatic infection in men and women. Men serve as a carrier of the bacteria even with asymptomatic infection, spreading the infection to other persons. Women have a higher probability to develop severe complications after infection. In an acute infection *C. trachomatis* can produce pelvic inflammatory disease (PID), which may include long

term consequences such as salpingitis, chronic pain, infertility, and ectopic pregnancy (Novak & Karlsson, 2006).

According to Morrison and Morrison (2005), even when antibiotics are effective against chlamydia, the definite control to eradicate this disease can be achieved with vaccination. The understanding of the human's immune response remains unclear. *Chlamydia muridarum* produces genital infections to mice which is very similar to the infection produced by *C. trachomatis* in humans (Morrison & Morrison, 2005). The immune response in mice followed by *C. muridarum* infection has been studied. Depletion of $CD4^+$ T cells antibodies in mice produces an infection that do not resolve. The mechanisms to develop protection against chlamydia will vary among host and cell mediated immunity (Morrison & Morrison, 2005). The antibody response is not well understood. It is known that the chlamydial elementary body is blocked in the presence of the antibody. Depletion of the antibodies may facilitate reactivation of the elementary body, and hence triggering infection (Morrison & Morrison, 2005).

Conjunctival infections can occur during labor from mothers to babies. The inflammation of the eyelid or trachoma is one of the most common infections causing blindness worldwide (Mariotti, Pascolini, & Rose-Nussbaumer, 2009). Over 140 million persons have conjuctival infection and 6 million are blind in regions such as Africa, Asia, and Latin America (Mariotti et al., 2009). The disease is prevalent in rural populations with limited personal hygiene and water. Trachoma is considered a communicable disease of families. Reinfection occurs mainly among families (Mariotti et al., 2009).

The transmission of *C. trachomatis* occurs trough infected secretion during sexual contact. Chlamydia penetrates areas such as cervix, urethra, rectum, throat and conjunctiva of the eyes (Novak & Karlsson, 2006). After spreading via sexual contact it manifests a disease (Novak & Karlsson, 2006).

Chlamydia trachomatis infection enhances other STDs colonization (Joyee et al. 2005). Serological tests for IgG antibodies against chlamydia are more likely found in those with *Neiserria gonorrhea* and HIV infected patients (Joyee et al., 2005; Vonck, Darville, O'Connell, & Jerse, 2011). Significantly more gonococci have been found in laboratory mice coinfected with chlamydia than those with gonorrhea alone. Chlamydia has been observed to induce alterations in the host's response enhancing the possibility of coinfection with other STDs (Vonck et al., 2011). Coinfection was not to be considered for the purpose of this study.

Chlamydia has shown to resolve without treatment. Factors of spontaneous cure are under study that should clarify a feasibility of a vaccine against chlamydia (Parks, Dixon, Richey, & Hook, 1997). Samples of untreated patients have been evaluated to detect those whose first culture is positive and without treatment the repeated cultures were negative. A retrospective study was performed with data derived from patients attending an STD Clinic in Birmingham, Alabama. Samples were taken prior a positive test for gonorrhea and a history of chlamydia infection. Chlamydia cultures of 325 patients presented positive growth between June 1992 and January 1996. Patients who received treatment were excluded from the study. There were 311 medical records evaluated and 74 did not receive treatment. Forty-five days after the initial positive

culture samples were retaken and cultures were repeated. The study population was five men and 69 women. The cultures revealed that 34 out of 74 patients resulted with a negative follow up culture (*P*=0.05, *RR*= 1.458, 95% *CI* 0.911-2.333). Those with persistent infections were treated with antibiotic (Parks et al., 1997). Age correlated with the clearance proportion. Those patients 30 years of age and older had the highest proportion of spontaneous clearance, seven out of 15. However, 16 patients were 15 to 19 years of age. Only three out of 16 of the younger population resulted negative in the test. Older patients may have developed a host response because they could have had the infection before and the immune system developed a memory against the infection.

Clinical Consequences

Cervicitis

The narrow neck of the uterus is named cervix and it is usually the initial site of the common STDs. The inflammation of the cervix is known as cervicitis, which is a common sequelae produced by *C. trachomatis* (Marrazzo & Martin, 2007). Mucopurulent cervicitis (MPC) is characterized by a visible purulent exudate. MPC is mainly asymptomatic but may produce endocervical bleeding. The condition may persist as a chronic cervicitis producing endometrial infection or may infect the uterus, fallopian tubes and ovaries producing PID (Marrazzo & Martin, 2007).

Pelvic Inflammatory Disease

PID is a clinical syndrome characterized by an infection and chronic inflammation of the uterus, fallopian tubes and ovaries or woman's pelvic organs. The chronic inflammation produced by PID causes damaging of the tissue (Buchholz &

Stephens, 2007). During the inflammatory process chemokine interleukin 8 (IL-8) is produced by the cells infected with chlamydia. IL-8 is necessary to activate neutrophils that in the presence of host's cells, chlamydia infection produces damaging to the surrounding tissues (uterus, fallopian tubes, ovaries, and pelvic organs). Consequently, chronic inflammation occurs, however the exact pathway stills unknown (Buchholz & Stephens, 2007).

Women infected with *C. trachomatis* have the possibility to develop PID more than any other bacteria (Oakeshott et al., 2010). The common signs are lower abdominal pain, irregular menstruation, fever, and chronic pelvic pain. Twelve percent of women will become infertile after the first episode of PID. Over 50% of women with a second episode of PID will become infertile. The highest incidence of PID is found among sexually active adolescent women between ages 15 to 19 years. Within this group, one out of eight women infected with Chlamydia develop PID, in contrast one out of 80 women 25 years of age or older develop PID. According to Oakeshott et al., women over 25 year are more likely to visit their physician to receive treatment than adolescents 15 to 19 years of age. This is the main reason of PID rate.

Each year, 200,000 women develop infertility as a consequence to chlamydia infection in the United States (Oakeshott et al., 2010). Positive associations have been observed in women with *C. trachomatis* and cervical premalignancies that could have been caused by an increased susceptibility to acquire Human Papilloma virus infections (Safaeian et al., 2010). According to Oakeshott et al. (2010), hospitalization is recommended to treat PID if the woman is pregnant, is having nausea, vomiting or fever,

and is not responding to oral medication. It is recommended testing all sexually active women for chlamydial infections, particularly those women who have multiple sex partners and all that are pregnant (Oakeshott et al., 2010).

Virulence Factors

C. trachomatis starts the colonization to the host's cells using the sialic acid receptors for attachment on the eye, throat or genital organs (Carlson et al., 2008). After penetrating to the body, human antibodies, T cells and B cells cannot recognize it. Chlamydia contains a unique gram negative cell wall that contains the outer lipopolysaccharide membrane, but lacks peptidoglycan layer. The lack of this layer does not permit antibodies to attach it, since this layer usually contains muramic acid which is the target of antibodies. Instead of muramic acid, the cell wall contains cysteine rich proteins that allow chlamydia to survive outside the host's cell (Brunham & Ladino, 2005).

The identification of a possible vaccine against chlamydia has been conducted (Swanson et al., 2009). According to Tan et al. (2010), all chlamydia species contain a polymorphic membrane protein D (PmpD) that suppresses host immunity. The mechanism of this protein is under study to produce a vaccine that could neutralize PmpD, conferring immunity to the host (Swanson et al., 2009). Azythromycin has become the drug of choice to treat chlamydia. One single dose is enough to treat and cure it (Porco et al., 2009).

Risk Factors

Age

A cross sectional study was conducted with prisoners attending a family clinic in a Swiss prison (Steiner et al., 2010). Participants were 18 to 35 years old. Questionnaires were completed about sociodemographic factors, used of IV drugs, health habits, antibiotic treatment within the past 3 months, and urogenital symptoms. There were 214 men and 20 women that participated in the study. Among the participants were Africans (49.5%), Europeans (31.5%), Asians (15.3%) and Americans (3.6%). 35.7% had a lower level of education. Urine samples were analyzed for chlamydia detection using PCR technique. Infection was found in 14 out of 214 males (6.5%, 95% CI 3.2–9.9) and in 2 out of 20 females (10%; 95% CI 0–23.1). The relationship of chlamydia infections and participants were as follows: 8.7 of the infected were under 25 years old, while 5.3 were higher 25 years old; 10% were women, 6.5% were men; 9.5% were symptomatic (presented uro-genital complications), while 3.9% were asymptomatic; 7.6% had 2 or more sexual partners in the last year, 6.4% had 1 sexual partner. Chlamydia was found to be higher in those below 25 years of age.

Corbeto et al. (2010) conducted a study in the province of Barcelona in 2007 regarding the prevalence of *C. trachomatis* infections and showed incidence rates significantly greater in those young women less than 25 years of age. Corbeto et al. used a sample of 397 adolescents and young women among 16 to 35 years. Findings revealed that *C. trachomatis* had an incident rate significantly higher in those under 25 years of age (5.8%), and 1.6% in those over 25 years of age. Risk factors were as follow: foreign

origin (OR 4.7, 95% CI 1.02-21.8); had a sexual partner in the last three months (OR 4.59 CI 1.16–18.08); and smoking tobacco in the last 12 months (OR 6.38 CI 1.16–34.93) (Corbeto et al., 2010). The study showed a higher trend of chlamydia infections in young women, which was consistent with the findings reported in the rest of Europe.

Klavs, Rodrigues, Welling, Kese, and Hayes (2004) conducted a study in Slovenia of the general population 18 to 49 years old to evaluate the prevalence of *Chlamydia trachomatis*. The objective of this national survey was to identify demographic factors and behavior to those infected with chlamydia. The study was conducted in different Slovenian health centers. Data collection starts in November 1999 ending February 2001. Questionnaires were administered to 849 men and 903 women ages 18 to 49. The number of participants the responded the survey were 683 and 764 women. Urine samples were used for testing *C. trachomatis*. Klavs et al. excluded those individuals who had never had sexual intercourse. The groups were distributed as follows: 18-24, 25-34, and 35-49. The prevalence among the population 18-24 was the highest (men and women 4.1%; CI 2.2 to 7.4), followed by the group 25-34 (men 3.6%; CI 1.6 to 4.9), (women 2.0%; CI 0.7 to 5.1), and then the group 35-49 resulted with lower risk (men 2.1%; CI 0.9 to 4.9), (women 0.3%; CI 0.0 to 2.0). Klavs et al. concluded that the prevalence of Chlamydia is higher in the population 18 to 24 years old.

Coinfection

Coinfection occurs when a simultaneous infection is produced by two or more pathogens. Under coinfection interactions, *C. trachomatis* is capable to enhance its transmission than as a single infection (Barbosa et al., 2010). *C. trachomatis* coinfections

have been associated particularly with *Neiserria gonorrhea* and *Trichomonas vaginalis* (Barbosa et al., 2010; Khan et al., 2005). Coinfection was not be considered for the purpose of this study.

A cross sectional study was performed in six STI clinics in Brazil in 2005 to assess the prevalence of *C. trachomatis* and *Neiserria gonorrhea* coinfection (Barbosa et al., 2010). The clinics were part of the Brazilian Public Health Care, which are free public clinics maintained by government. Patients had no costs for medical visits, laboratory tests or treatment. The study required to enroll 750 participants to provide 80% power to estimate the prevalence of *C. trachomatis* (Barbosa et al., 2010). Informed consent from parents was obtained for those under 18 years old. A total of 767 men participated in this study. The mean age was 26.5 years, with a standard deviation of 8.3 years. (SD 8.3). HIV positive men were excluded from the study. The prevalence of chlamydia infection was 13.1% (95% CI 10.7%-15.5%), while gonorrhea was 18.4% (95% CI 15.7%-21.1%). Coinfection was 4.4% (95% CI 2.95%-5.85%). Demographic patterns and STD prevalence showed that 52.4% were men 15 to 24 years old; 59.8% of those infected were unmarried and 73.5% had an income below the Brazilian minimum wage. The factors identified to present coinfection were participants among 15-24 years old, presented urethral discharge, and have had genital warts. The main risk factors were found as multiple sexual partners and inadequate condom use. The screening showed that coinfection with gonorrhea is more likely in younger people (below 25 years old; Barbosa et al., 2010).

Between April 2000 and October 2003, Khan et al. (2005) studied sexually active males and females who visited a STI clinic in Indianapolis, IN. Participants were heterosexual between the ages of 15 to 25 years of age. The objective was the study was to estimate the rate of *Chlamydia*, *Neiserria gonorrhea* and *Trichomonas vaginalis* coinfections (Khan et al., 2005). The number of participants was 210, 101 males and 109 females. The results were as follow, 46% had *Chlamydia*, 18% had *N. gonorrhea* and 14% had *Trichomonas vaginalis*. The partners of 72 subjects infected with chlamydia were contacted and tested for the same bacteria. Partners' results were as follow, 57% had *Chlamydia* and *N. gonorrhea* co-infection, and 20% had *Trichomonas vaginalis.* Participants and partners received treatment. The study discusses that there are substantial numbers of *Chlamydia-N. gonorrhea* coinfections that can be associated with other STIs, such as *Trichomonas vaginalis.* Khan et al. concluded that patient-delivered partner therapy (PDPT) is an effective strategy to decrease the risk of reinfection in patients, since most of the time sexual dyad members share the same infections.

Sexual Partners

Treatment of sexual partners has proved to be an effective strategy in preventing and reducing coinfections and STI sequelae (Khan et al., 2005). Many infected partners do not receive treatment. Partner notification is the way the health care provider ensure the proper treatment for persons implicated. When there is more than one partner the notification occurs at low rates producing difficulties to seek health care attention (Khan et al., 2005). Commonly, sexual partners share the same STIs than index subject. There are a number of partners that also have other infections that do not share the index subject

(Khan et al., 2005). The patient-delivered partner therapy (PDPT) is an effective strategy to decrease the risk of reinfection.

The English National Chlamydia Screening Program, in UK, performed a cost effectiveness treatment for those sexual partners of subjects diagnosed with *C. trachomatis.* The study was conducted in 2008-2009, of notification and screening of sexual partners. The model showed that notification and proper treatment will reduce the cost per infection over six times (Turner et al., 2011). The notification and treatment is likely to cost less than if partners never receive proper attention. The probability of reinfection after counseling and treatment was also reduced dramatically, and long term complications associated with chlamydia. The study was limited to chlamydia infections only.

Socioeconomic Status

Chlamydia infections have been associated with socioeconomic status (Radcliffe, Ahmad, Gilleran, & Ross, 2001). A case-control study was performed from June 1997 to June 1998 in the Whittall Street Clinic in Birmingham. This clinic is part of the National Health Service and a free STI clinic in UK. Participants completed a questionnaire about age, sex, marital status, ethnic group, occupation, income, number of partners, use of condom, tobacco, alcohol and drug habits and previous diagnosis of chlamydia and *N. gonorrhea*. A power analysis suggested a sample size of 1124 participants for a power of 80% with a confidence level of 95%. The study recruited 1371 participants (526 cases and 845 controls). All participants were tested for chlamydia and *N. gonorrhea* using urine, urethral and cervix samples. Cases were subjects infected with chlamydia, but not

N. gonorrhea. Controls were those free of both infections. Characteristics and demographic factors of those with chlamydia showed, 149 (24%) never use condom; 415 (67%) sometimes use condom; 88 (12%) had a previous history of gonorrhea; 115 (17%) had a previous history of chlamydia; 289 (30%) were smokers; 302 (31%) consumed alcohol; 91% of infected participants were unmarried; 279 (28%) were under 24 years old; 130 (20%) were unemployed; 143 (23%) were students; 42 (7%) were homemakers and 318 (50%) had low salary income. *Chlamydia* infections were associated with decreased condom use, being single, low income and age less than 24 years (Radcliffe et al., 2001).

Chlamydia Reinfections

C. trachomatis reinfections are very common among middle and high school students (Gaydos et al., 2008). In a school based study performed between 1996-2003, 10,609 high school students females were tested for the presence of chlamydia. Reinfection was considered when positive results occur between 30 to 365 days after the initial positive result. The first test was at 30 days, and then a second test was in 3 months, a third test was in 9 months, and last test in 1 year. There were 897 females that resulted positive, and were retested within 1 year. From these there were 236 that resulted with reinfection after 1 year follow up. Gaydos et al. presented that in 1996 there were 512 females tested, from that 82 (CI 12.8-19.2) were positive for chlamydia, within 1 year 13 (CI 12.9-36.1) had reinfection. At the end of the study in 2003, there were 1922 females tested for chlamydia, from that 364 (CI 18.9-20.6) were positive, within 1 year

27(CI 14.4-28.8) were reinfected. The incidence of reinfection since 1996 to 2003 was 26.3% (95% CI 23.4-29.2%) within 1 year.

Chlamydia reinfections occur because untreated partners may have different sexual partnerships (Heijne et al., 2010). Reinfection after treatment is very common due to failure to screen partners, or subsequent partners have asymptomatic infection. A chlamydia infection process model was developed following the model of Kretzschmar and Dietz (1998). The model was used to predict the re-infection process. *C. trachomatis* transmission occurs if there is a susceptible host, and only one infected partner is necessary to transmit the disease. The majority of individuals with asymptomatic infection will never know about the infection. Only 30% of the asymptomatic infections could be detected if they are partners of a symptomatic or under treatment person. Continuous reinfection will occur since the disease is mainly asymptomatic and no notification for treatment is received.

Intervention Effectiveness

Condom use and Behavioral Interventions

A study to promote behavioral intervention to promote condom use was conducted in Ciudad Juarez, and Tijuana Mexico between January 2004 to January 2006 (Patterson et al., 2008). Patterson et al. recruited 924 female workers. The eligibility requirements were being older than 18 years, having traded sex for money or drugs within the previous 2 months of the study, and no condom use. Baseline and behavioral interventions were conducted. Baseline and follow up included working with self-esteem, sociodemographic conditions, alcohol, and drugs use, and safety of condom use.

Behavioral interventions were conducted in two groups, Mujer Segura Intervention (Healthy Woman), and didactic control group. Motivational techniques were used such as to protect one's own health, to avoid STIs, to feel clean, safer sex with clients, and engagement of protection. The didactic control group was exposed to a weekly computer program providing information about HIV and STI. Blood tests were collected to conduct syphilis and HIV tests. Chlamydia and gonorrhea tests were conducted from vaginal swabs. At baseline, 55 out of 924 resulted with HIV, and 869 were negative; 132 had syphilis, 25 had gonorrhea, and 48 had chlamydia. Participants received treatment. After 6 months follow up, the incidence of HIV was 0 out of 869 originally seronegative; 6 had syphilis; 9 had gonorrhea and 13 had chlamydia. Patterson et al. showed that behavioral interventions integrating a change of behavior can significantly reduce unprotected sex, HIV and STI incidence. Interventions addressed the social and cultural conditions to identify barriers and solutions to set the adequate counseling.

A Transtheoretical Model of Change (TTM) has been used as a framework for behavioral interventions such as protective behaviors, condom use and STI prevention (Chacko et al., 2010). The TTM promotes that individuals adopt and maintain a positive behavior. A randomized controlled clinical trial was conducted in an urban clinic in Texas, from May 2002-February 2003. Participants were women, English speakers, not pregnant, single, HIV negative, who did not use alcohol or drugs. The number of eligible participants was 950. Behavioral interventions were conducted at baseline, 2 weeks, 6 months, and 12 months. Interventions were oriented to condom use, the importance of decisions, sexual partners and having STIs. The results showed that the number of

chlamydia and gonorrhea decreased after 12 months follow up, and the condom use increased from 7% at baseline to 13% at the end of the study (Chacko et al., 2010).

Mass Treatment of at Risk Population

Oral Azithromycin has been used to treat communities to control the spreading of *C. trachomatis* infections from mothers to babies. During labor, mothers infect their babies causing trachoma to the eyes, which is the leading cause of blindness worldwide (Porco et al., 2009). Mass treatment in Tanzania was conducted in children and their parents (Cajas et al., 2011). Treatment was given to all families who live distance of source of water and had presence of one or more flies on the face. Swabs of the eyelid were collected before treatment. Single dose of Azithromycin 20 mg was given to all children 6 months and older in four villages. There were 1,991children treated at baseline. From that 1,412 were negative for the test and treated at baseline; 81 were not treated at baseline and not infected; 445 were infected and treated and 18 were infected but not treated. According to Cajas et al. (2011), mass antibiotic treatment as a goal to control chlamydia infection, and recommended treating every 6 months families and children in places where trachoma is a concern.

Treatment

C. trachomatis is a treatable disease that requires treating all sex partners of those who have resulted positive for chlamydia. According to Porco et al., (2009), Azithromycin 1 gram orally in a single dose is the drug of choice because it has been demonstrated a cure rate of 98% of the cases. Azithromycin is especially the best drug since this antibiotic is used in a single dose and no posterior doses are necessary. As a

follow up treatment it is recommended to retest the patients after 3 to 4 weeks of completing the therapy to evaluate if the person is cured. The majority of the post treatment infections occur because sex partners have failed to be treated and have no notification for treatment (Porco et al., 2009).

Critique of Methods

Methodologies of studies presented in this proposal mention reinfection and coinfection risk factors associated with age, notification and treatment of sexual partners, socioeconomic status, condom use and behavioral interventions and mass treatment. Cross sectional studies presented on this chapter demonstrated health related aspects, sociodemographic characteristics, gender and age as potential risk factors for the prevalence of *Chlamydia trachomatis* among certain groups of people (Corbeto et al., 2010; Klavs et al., 2004; Steiner et al., 2010). However, no researcher mentioned the impact of behavioral interventions and/or counseling.

Patient-delivered partner therapy has showed to be an effective strategy to decrease the risk of chlamydia reinfection (Turner et al., 2011). According to Kretzschmar and Dietz (1998), an infection process is the key to predict the reinfection in susceptible hosts, and only one infected partner is necessary to transmit the disease. Continuous re-infection will occur if partners' notification and treatment are not accomplished. These researchers did not present counseling as part of the partners' therapy. Behavioral interventions such as the Trans theoretical Model of Change proposed by Chacko et al. (2010) showed that interventions oriented to sexual protection

can decreased dramatically the rate of reinfection within the period of follow up treatment.

Prevention

Chlamydia is a preventable disease that requires different strategies to be controlled (DiClemente et al., 2007). Low prevalence of consistent condom use, not giving treatment to sexual partners, and multiple sexual encounters can increase the risk of chlamydia acquisition. So the basis of the prevention counseling is to minimize sexual risk behavior through modifying the risk factors in order to have lower rates of reinfection.

Experiments with animal models and limited human studies have suggested that the response against *C. trachomatis* could be mediated by a strong interferon (IFN). This response may neutralize *C. trachomatis* activity. A model for a vaccine has been proposed by Gray, Beagley, Timms, & Wilson (2009). There is evidence that the experimental vaccine could induce partial immunization against *C. trachomatis.*

DiClemente et al. (2007) presented a public health concern and have tried to prepare risk reduction programs and targeting to workers, schools and community programs. According to Lee, Jung, Kwon, Jung, and Park (2010), chlamydia is preventable if there are resources for protection programs. These authors performed a cross sectional study in Korea for condom use among females in 2004. After the study, women revealed to be more conscious toward self-protection, prevalence, and consequences of chlamydial infections.

Summary

Chlamydia infections have been shown to be the most common STI in the United States, and are most of the time asymptomatic (Gottlieb et al., 2010). The infection can produce serious complications such as salpingitis, PID and coinfections with gonorrhea, *Trichomonas vaginalis,* and genital warts. The literature reviewed show that chlamydia is a preventable disease that can be controlled with notification and treatment of sexual partners, screening for reinfections and participation in a program for sexual education. Low prevalence of *C. trachomatis* is strongly related with behavioral modifications, responsibility, and consistent condoms use (Lee et al., 2010). A knowledge gap is associated with its high prevalence, reinfection rate and morbidity. It is important to emphasize that the highest incidence occurs in young people 15 to 20 years of age. Chapter 3 is a presentation of the study design and method of this study.

Chapter 3: Research Method

Introduction

Chlamydia trachomatis is the most common STI reported worldwide (Gottlieb et al., 2010; Oakeshott et al., 2010). It is an obligate intracellular bacterium that produces genital tract infections in both women and men. Untreated it causes pelvic inflammatory disease, which may result in infertility, severe pelvic pain, and ectopic pregnancy, also enhances the susceptibility of coinfections with gonorrhea, *Trichomonas vaginalis*, genital warts, and HIV (Molano et al., 2005; Novak & Karlsson, 2006). Chlamydia exposure increases the probability of HIV infection (Joyee et al., 2005). According to Advocates for Youth (2008), Puerto Rico resulted within the top 10 highest incidence of HIV cases in 2004. However, the infection often remains asymptomatic and thus undiagnosed and untreated. Highest incidence is reported in young adolescents ages 15 to 19 (DiClemente et al., 2007).

CDC (2010) guidelines for STD Treatment established the following medical care for Chlamydia:

> Repeat infections confer an elevated risk for PID and other complications. Unlike the test-of-cure, which is not recommended, repeat C. trachomatis testing of recently infected women or men should be a priority for providers. Chlamydia-infected women and men should be retested approximately 3 months after treatment, regardless of whether they believe that their sex partners were treated. If retesting at 3 months is not possible, clinicians should retest whenever persons next present for medical care in the 12 months following initial treatment.

According to The Department of Health of Puerto Rico (2012), the majority of people infected with chlamydia receive appropriate antibiotic therapy. The Health Department takes care of detection of other STDs, and retests them for reinfections. However, prevention counseling for STDs reoccurrence is mainly voluntarily. During routine visits and/or exams, adolescents decide if they will participate in safer sex counseling and orientation. Reinfections patterns could be link with a knowledge gap. *Chlamydia trachomatis* and STDs should be not only additional testing, but proper counseling and support is needed.

To address the proper counseling and knowledge gaps, a secondary data analysis from a historical-prospective study was proposed to explore the management of Puerto Rican adolescents (15 to 19 years old) following a chlamydia infection, which includes antibiotic treatment, partners' notification, reinfection and safer sex counseling and orientation.

Research Questions

Research Question 1

Is the high rate of *Chlamydia trachomatis* reinfection outcomes in Puerto Rican adolescents associated with failure to receive antibiotic therapy and to follow the retesting protocol established by the Health Department?

Reinfection occurs when after initial treatment the same infection occurs again. Reinfection is common after treatment. For that reason, the CDC (2010c) recommended follow up symptoms and condition after 3 to 4 weeks, 3 months and 12 months after

completing therapy to evaluate if the person is cured, for new symptoms and if reinfection and/or coinfection are suspected (CDC, 2010c).

In this study, a multiple logistic regression model was used as quantitative method to associate reinfection with failure to receive antibiotic therapy and to follow the retesting protocol established by the Health Department. Reinfection was measured as dependent variables and failure to receive antibiotic therapy and to follow the retesting protocol were measured as independent variables.

Research Question 2

Is *Chlamydia trachomatis* reinfection outcome in Puerto Rican adolescents associated with gaps in notification and screening sexual partners for infection?

The CDC (2010c) recommended referring sexual partners for evaluation and treatment if infection is suspected. Antibiotic therapy can be delivered with patient itself as chlamydia reinfection is associated with failure of sexual partners to receive treatment (CDC, 2010c). In this study a multiple logistic regression model was used to associate reinfection patterns with gaps in notification and screening sexual partners. Reinfection was measured as dependent variable and gaps in notification and screening sexual partners were measured as independent variables.

Research Question 3

Is *Chlamydia trachomatis* reinfection in Puerto Rican adolescents associated with participation in the sexual orientation program about risk factors offered by the Health Department during chlamydia treatment?

The CDC (2010c) recommended that patients need to receive counseling, testing and treatment for any STD. A behavioral change has been presented as a public health solution to reduce the risk factors associated with STDs (DiClemente et al., 2007). In this study a multiple logistic regression model was used to measure the association of reinfection patterns with the participation in the sexual orientation program about risk factors. Reinfection was measured as dependent variables and the participation in the sexual orientation program about risk factors was measured as independent variable. Patients' risk factors evaluated were the following: patient risk history with two or more sex partners during chlamydia treatment, new sex partners during chlamydia treatment, and condom use.

The following figure shows the process to study of reinfection variables.

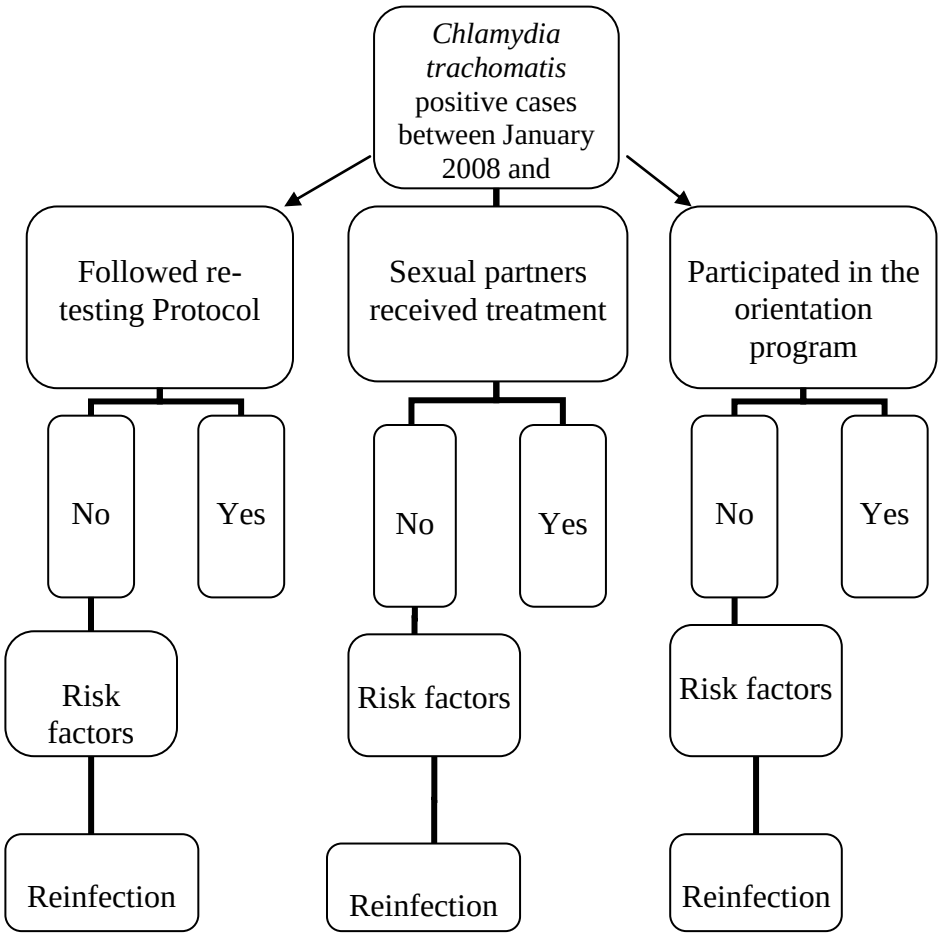


Figure 2. Diagram showing *Chlamydia trachomatis* reinfection patterns.

- Retesting protocol, participation in the orientation program and notification and treatment of partners means independent variable.
- Reinfection means dependent variable or outcome.
- Follow up period means after 3 to 4 weeks after initial treatment, at 3 months and 12 months.

Study Procedure

1. The study consisted in evaluating secondary data from the Health Department of Puerto Rico of adolescents 15 to 19 years old who had a positive *Chlamydia trachomatis* laboratory result. According to the Sexually Transmitted Disease Treatment Guidelines from the CDC (2010), after receiving treatment for *Chlamydia trachomatis* infection patients should be tested after 3 to 4 weeks, 3 months and 12 months in order to evaluate if the infection was resolved.
2. Antibiotic therapy and follow up after 3 to 4 weeks, 3 months and 12 months were considered.
3. Notification and treatment of sexual partners were evaluated. CDC guidelines and The Health Department of Puerto Rico recommend treating sexual partners to reduce the adverse outcomes of post transmission.
4. Participation in the sexual orientation program about risk factors and STD prevention was evaluated to establish if those who did not participate were at higher risk of reinfection. During the sexual orientation program, it is discussed if the patient has had two or more sex partners during chlamydia treatment, new sex partners during chlamydia treatment, and condom use. Low prevalence of consistent condom use and multiple sexual partners can increase the risk of chlamydia acquisition.

Research Design

The Health Department of Puerto Rico has 10 public health clinics around the Island for STDs tests and prevention services. Testing, screening, and treatment protocols are followed based on the STD Treatment Guidelines from the CDC (2010). Patients' data are filled out in a questionnaire by the public health personnel about race, ethnicity, physical address, age (including minors), and reason for visit/test, type of health care provider, laboratory test type, patient risk history, contacts or partners, and clinical findings. As part of the STDs screening of the Public Health Clinics, patients provide samples for testing. For *Chlamydia trachomatis* screening patients must provide urine samples collected into a sterile container. Urine samples are analyzed in the clinical laboratory of the Health Department by authorized personnel. Patients are screened with or without symptoms as routine test or follow up after treatment.

Multiple STD tests on the same person are able to be linked under a unique record number. Patients with any positive *Chlamydia trachomatis* result test start its correspondent's treatment. A single dose of Azythromycin 1g is given as treatment for *Chlamydia trachomatis*. Patient interview is necessary to evaluate the risk factors associated with STDs; they are also advised to refer their partners to the Health Department for proper treatment. Patients are then cited for follow up treatment after 3 to 4 weeks, eventually at third month follow up, and after 12 months in order to evaluate if there is a sustained negative result in those patients under antibiotics treatment. Eventually, all data are collected into a STD MIS official software program under the Health Department custody. The purpose of this study was to investigate the relationship

between *Chlamydia trachomatis* reinfection among sexually active adolescents 15 to 19 years old.

Participants

The study was based on existing data since January 2008 through December 2012, from adolescents 15 to 19 years old, collected under the STD MIS software program of the Health Department of Puerto Rico. I had the intention to measure the follow up treatment and safer sex counseling and orientation based on CDC guidelines. Electronic documentation provided by the Health Department was evaluated: screening of reinfections, antibiotic therapy, notification and treatment of sexual partners, and participation in the sexual orientation program about risk factors offered by the Health Department. Risk factors discussed in the sexual orientation program are, two or more sex partners during chlamydia treatment; new sex partners during chlamydia treatment; and condom use.

Sample Population

I intended to examine all *Chlamydia trachomatis* positive cases identified by the Health Department of Puerto Rico between January 2008 and December 2012. Measures of association between risk factors (IVs) and outcomes (DVs) were determined using a tabulation of those adolescents reinfected and those initially infected from a historical prospective study in Puerto Rico since 2008-2012. There were a total of 9,022 *Chlamydia trachomatis* cases in the ages 15-19 years old since 2008-2012. The entire population was considered in this study.

The STD MIS official software program under the Health Department of Puerto Rico provided the positive *Chlamydia trachomatis* cases in adolescents 15 to 19 years old that were tested in the public health clinics of the Health Department of Puerto Rico. This information was limited to unique client number identifier, age, sex, date of initial positive chlamydia test, treatment date, follow up treatment, result of follow up, history of re-infection, sexual partners' notification and treatment and participation in the sexual orientation program about risk factors, number of sexual partners during chlamydia treatment, and condom use. This was the population analyzed for this study purposes.

Specimen Collection

Data for the study already exist based on samples collected by the Public Health Department of Puerto Rico. Specimens' collection for *Chlamydia trachomatis* was following the STD Treatment Guidelines from the CDC (2006a, 2010c). Urine samples were taken by each patient and placed into a sterile container and sent to the laboratory, Samples were sent to the public health clinics laboratory where authorized personnel tested the samples for the corresponding analysis. Each sterile container was labeled with patient's name, date of collection and specimen's source.

Laboratory Testing

The nucleic acid amplification technique (NAATs) was used to analyze and detect the presence of *Chlamydia trachomatis* in the samples submitted by the patients. The method is also used to detect *N. gonorrhea*. The assay is used to detect chlamydia in both symptomatic and asymptomatic individuals. The test is performed to endocervical samples, vaginal swabs, male urethral swabs, and female and male urine. The

characteristic of NAATs is that is designed to amplify the nucleic acid of the organism. Historically, cell culture has been considered as the gold standard for chlamydia detection. Since there have been discrepancies between laboratories, cell culture has been replaced by NAAT.

Aptima Combo 2 predictive values for positive and negative results were calculated based on hypothetical prevalence. The sensitivity and specificity for *Chlamydia trachomatis* are 96.1% specificity and 98.0% sensitivity. NAATs produce positive signal when a single copy of ribosomal RNA (rRNA) is found in the sample. Specific region for *Chlamydia trachomatis* is found in 23S rRNA (Gen-Probe, 2012).

Data Collection

Public Health Clinics in Puerto Rico receive many patients for Sexually Transmitted Diseases analysis. Some STD patients may be diagnosed and treated by private clinicians and eventually called and interviewed by the Public Health Clinic personnel. Partners are advised by the patient who resulted with a positive test to visit the public health clinics to receive treatment. Participation and education of partners for safer sex is mainly voluntary. Interviews, analysis, and proper treatment are given to those partners who visit the clinics. There is no evidence whether or whether not a lack of educational counseling could be linked with reinfections patterns among Puerto Rican adolescents.

A data use agreement form authorized by the Walden's Institutional Review Board (IRB) was used as an agreement with the Health Department of Puerto Rico to access the information provided by the STD MIS official software program. Information

requested was, patient antibiotic therapy, follow up retesting protocol, history of chlamydia reinfection, documentation of notification and treatment of sexual partners, participation in the sexual education program about risk factors, history of two or more sex partners during chlamydia treatment, new sex partners during chlamydia treatment, and condom use. All information provided by this program is under a unique record number for each participant. The unique record number is retained for each patient so records can be linked. There is no name under this program. Reinfection is considered after 30 days of initial treatment.

Data Analysis

Data analysis was restricted to adolescents 15 to 19 years old who had *C. trachomatis* infection and reinfection patterns since January 2008 through December 2012. STD MIS software used in the Puerto Rico Health Department was used using the record number of each *Chlamydia trachomatis* positive cases since 2008 through 2012 from the adolescents' population 15 to 19 years old. Once the population was selected reinfection with chlamydia was investigated using the same record number.

STD MIS System provided the following information for the purpose of this study:

1. Unique participant record number to ensure unduplicated record.
2. Participant age and gender at the time of initial chlamydia positive result.
3. Date of initial chlamydia positive result.
4. Date of follow up treatment.
5. Date of reinfection.

6. Condom use after positive chlamydia test result.
7. Number of partners during treatment.
8. Documentation of notification and treatment of sexual partners.
9. Documentation of orientation of the sexual program about risk factors offered by the Health Department during chlamydia treatment.

The epidemiology model proposed was based on a multiple logistic regression to establish the association of reinfection those adolescents. This model provided a rationale of the odds of and occurring outcome as (DVs). Adjusted odd ratio (OR) was used to present the probability of the occurring event in those adolescents reinfected and those initially infected. STD MIS software contains demographic information of each participant of the public health clinics under a unique record number. The same number was used for routinely visits. There is no participants' name under this system; there is no personal intervention with participants in this research. All information gathered was used for this research purpose only.

Summary

The purpose of this study was to conduct a secondary data analysis to evaluate risk factors associated with *C. trachomatis* reinfection among Puerto Rican adolescents aged 15 to 19 years. Predictors to study were postperiodic and follow-up treatment, notification and screening of sexual partners, and participation in the sexual orientation program about risk factors offered by the health department. Chapter 4 is a report of the results.

Chapter 4: Results

Introduction

The purpose of this study was to investigate the association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy and to follow the retesting protocol, failure of sexual partners to receive treatment, and failure to participate in the sexual orientation program about risk factors. I used secondary data to enable historical prospective study in cooperation with the Health Department of Puerto Rico. Data analysis was restricted to adolescents 15 to 19 years old who had a positive *C. trachomatis* result and reinfection pattern during the period January 2008 through December 2012.

Research Questions and Hypotheses

Research Question 1

Is the high rate of *Chlamydia trachomatis* reinfection outcomes in Puerto Rican adolescents associated with failure to receive antibiotic therapy and to follow the retesting protocol established by the health department?

$H1_0$: There will not be a significant association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy and to follow the retesting protocol established by the health department.

$H1_A$: There will be a significant association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy and to follow the retesting protocol established by the health department.

The results showed that there is a significant association between *Chlamydia trachomatis* reinfection and failure to follow the retesting protocol established by the Health Department. The statistical result had the *OR*=1.243, 95% *CI* 1.089-2.930. The information provides evidence to reject the null hypothesis.

Research Question 2

Is *Chlamydia trachomatis* reinfection outcome in Puerto Rican adolescents associated with gaps in notification and screening sexual partners for infection?

$H2_0$: There will not be a significant association between *Chlamydia trachomatis* reinfection and failure of sexual partners to receive treatment.

$H2_A$: There will be a significant association between *Chlamydia trachomatis* reinfection and failure of sexual partners to receive treatment.

The result showed that reinfection is more likely to occur when sexual partners do not receive treatment. Analysis revealed that the *OR*=1.713, 95% *CI* 0.761-2.024. The information provides evidence to reject the null hypothesis.

Research Question 3

Is *Chlamydia trachomatis* reinfection in Puerto Rican adolescents associated with participation in the program of sexual orientation about risk factors offered by the health department during chlamydia treatment?

$H3_0$: There will not be a significant association between reinfection with participation in the program of sexual orientation about risk factors offered by the health department during chlamydia treatment.

$H3_A$: There will not be a significant association between reinfection with participation in the program of sexual orientation about risk factors offered by the health department during chlamydia treatment.

The results showed an association between reinfection and no participation in the sexual orientation program. Analysis revealed that the *OR*=1.243, 95% *CI* .762-2.026. The information provides evidence to reject the null hypothesis.

Data Collection

Walden University's IRB approved this research, IRB Approval Number 03-24-14-0106581. After the approval, data collection started. For the purpose of this study, STD MIS data were downloaded and transported to the statistical program SPSS 22.0.

Descriptive Statistics

Data provided by the Puerto Rico Department of Health consisted of those positive *Chlamydia trachomatis* cases in adolescents 15 to 19 years and reinfection during the period January 2008 through December 2012. The demographic information was limited to age and gender. The clinical information was limited to positive chlamydia result, those who attended the Department of Health to be retested (follow up treatment), chlamydia reinfection, sexual partners' notification, and participation in the sexual orientation program about risk factors. There were a total of 9,022 *Chlamydia trachomatis* cases in the ages 15-19 years old since 2008-2012. The entire population was considered in this study.

Information used were from adolescents whose initial *Chlamydia trachomatis* occurred within the study period. Table 2 presents the demographic information of the study population.

Table 2

Demographic Information of the Study Population 15-19 Years old From 2008-2012

Gender	Infected		Reinfected	
	N	%	*N*	%
Male	1,279	14.2	72	0.8
Female	7,743	85.8	238	2.6
Total	9,022	100	310	1.7

	Infected				Reinfected			
Age	Male	%	Female	%	Male	%	Female	%
15	61	0.7	486	6.3	0	0.0	0	0.0
16	111	1.2	1,001	12.9	2	0.0	4	0.0
17	279	3.1	1,426	18.4	12	0.1	22	0.2
18	362	4.0	2,281	29.5	22	0.2	63	0.7
19	466	5.2	2,549	32.9	36	0.4	149	1.7

Source: Department of Health of Puerto Rico (2013).

The population analyzed was 9,022 adolescents infected for first time with *Chlamydia trachomatis*, ages 15 to 19 years old from 2008-2012. The population initially infected was 1,279 males (14.2%) and 7,743 females (85.8%). The population reinfected was 72 males (0.8%) and 238 females (2.6%). Population was distributed by age and gender.

Table 3 presents the descriptions of the follow up treatment, sexual partners' treatment, and participation in the sexual orientation program.

Table 3

Descripton of the Study Population 15-19 years old from 2008-2012

Subpopulations	*Subpopulation Size "n"*	*% Based on N=9,022*	*% Based on Re-infections N=310*	*%Based on subpopulation "n"*
Initially infected that followed the retesting protocol			-	
Male	736	8.2		13.9
Female	4,549	50.4		86.1
Total	5,285	58.6		100.0
Initially infected that did not follow the retesting protocol			-	
Male	471	5.3		13.8
Female	2,956	32.8		86.2
Total	3,427	38.1		100.0
Reinfected that followed the retesting protocol				
Male	13	0.1	4.2	12.2
Female	94	1.0	30.3	87.8
Total	107	1.1	34.5	100.0
Reinfected that did not follow the retesting protocol				-
Male	59	0.6	19.0	29.0
Female	144	1.6	46.5	71.0
Total	203	2.2	65.5	100.0
Initially infected whose sexual partners received treatment			-	
Male	698	7.7		12.8
Female	4,573	50.7		87.2
Total	5,271	58.4		100.0
Initially infected whose sexual partners did not receive treatment			-	
Male	571	6.3		16.6
Female	2,870	31.8		83.4
Total	3,441	38.1		100.0
Reinfected whose sexual partners received treatment				

Male	10	0.1	3.2	7.9
Female	116	1.3	37.5	92.1
Total	126	1.4	40.7	100.0
Reinfected whose sexual partners did not receive treatment				
Male	62	0.7	20.0	33.7
Female	122	1.4	39.3	66.3
Total	184	2.1	59.3	100.0
Initially infected that participated in the sexual orientation program			-	
Male	648	7.2		12.8
Female	4,423	49.0		87.2
Total	5,071	56.2		100.0
Initially infected that did not participate in the sexual orientation program			-	
Male	566	6.2		15.4
Female	3,075	34.1		84.6
Total	3,641	40.3		100.0
Reinfected that participated in the sexual orientation program				
Male	9	0.1	2.9	8.6
Female	96	1.1	31.0	91.4
Total	105	1.2	33.9	100.0
Reinfected that did not participate in the sexual orientation program				
Male	56	0.6	18.1	27.3
Female	149	1.7	48.0	72.7
Total	205	2.3	66.1	100.0

Source: Department of Health of Puerto Rico (2013).

The number of initially infected attending the Department of Health and that were retested (follow up treatment) resulting with a negative *Chlamydia trachomatis* result was 736 males (13.9%) and 4,549 females (86.1%). The number of initially infected whose sexual partners received treatment were 698 males (12.8%) and 4,573 females (87.2%). Initially infected that participated in the sexual orientation program were 648 males (12.8%) and 4,423 females (87.2%).

The number of reinfected that followed the retesting protocol was 13 males (12.2%) and 94 females (87.8%). Reinfected whose sexual partners received treatment were 10 males (7.9%) and 116 females (92.1%). Reinfected that participated in the sexual orientation program were 9 males (8.6%) and 96 females (91.4%).

I used the statistical program SPSS 22.0 to analyze the data in Multiple Logistic Regression Model to measure the relationship between the dependent variable (reinfection) and the following independent variables.

- Failure to follow the retesting protocol established by the Health Department.
- Gaps in notification and screening sexual partners.
- Failure to participate in the sexual orientation program about risk factors.
- The association between age and gender and chlamydia reinfection.

Multiple Logistic Regression

To determine the association between three independent variables in this study to predict *Chlamydia trachomatis* reinfection, multiple logistic regression was analyzed. The result of this regression reveals an association between failure to follow the retesting

protocol and the outcome. There is a statistically significant difference between initially infected adolescents that attended the Department of Health to be retested for chlamydia reinfection (follow up treatment) and those reinfected who did not follow the retesting protocol. Those who did not follow the retesting protocol are more likely to have a reinfection (*OR*=1.243, 95% *CI* 1.089-2.930, *p*-value 0.038). However, there are no statistically significant differences between females and males (*OR*=0.992, 95% *CI* 0.561-1.756, *p*-value 0.979). There are no statistically significant differences between age group 16-17 and age group 18-19 (*OR*=1.943, 95% *CI* 0.877-4.303, *p*-value 0.102).

With regard to sexual partners' treatment, the logistic regression showed that there is a statistically significant association in those reinfected adolescents whose sexual partners did not receive treatment (*OR*=1.713, 95% *CI* 0.761-2.024, *p*-value 0.029). No statistically significant differences were found in age (*OR*=0.845, 95% *CI* 0.569-1.768, *p*-value 0.544) or gender, (*OR*=1.943, 95% *CI* 0.318-1.242, *p*-value 0.182).

Regarding the participation in the sexual orientation program, there is a statistically significant association in those adolescents that did not participate in the sexual orientation program (*OR*=1.243, 95% *CI* 0.762-2.026, *p*-value 0.034). Age or gender does not show statistically significant differences. Age 18-19 has *OR*=1.087, 95% *CI* 0.526-2.249, *p*-value 0.822; and females have *OR*=1.003 *CI* 0.569-1.768, *p*-value 0.992.

With regard reinfection based on age and gender, there is a statistically significant association between reinfected females with reinfection (*OR*=1.976, 95% *CI* 1.605-2.334, *p*-value 0.009). Based on age, there is a statistically significant association between

reinfected age group 18-19 and reinfection (*OR*=1.911, 95% *CI* 1.556-2.266, *p*-value 0.006).

Table 4 summarizes the Multiple Logistic Regression results.

Table 4

Multiple Logistic Regression to Predict Factors Associated With Chlamydia Reinfection Among Adolescents 15-19 Years old from 2008-2012

Characteristics	B	S.E.	Wald	Sig.	Exp(B)	95.0% CI for Exp (B)
Reinfected that attended the Department of Health to be retested for chlamydia reinfection (follow up treatment)						
Yes (Reference)						
No	0.217	0.249	0.758	**0.038***	1.243	1.089-2.930
Gender						
Male (Reference)						
Female	-0.008	0.291	0.001	0.979	0.992	0.561-1.756
Age						
16-17 (Reference)						
18-19	0.664	0.406	2.680	0.102	1.943	0.877-4.303
Reinfected whose Sexual Partners received treatment						
Yes (Reference)						
No	0.538	0.246	4.796	**0.029***	1.713	0.761-2.024
Gender						
Male (Reference)						
Female	-0.168	0.277	0.369	0.544	0.845	0.569-1.768
Age						
16-17 (Reference)						
18-19	-0.464	0.348	1.785	0.182	0.628	0.318-1.242
Participation in the sexual orientation program						
Yes (Reference)						
No	0.217	0.249	0.758	**0.034***	1.243	0.762-2.026
Gender						
Male (Reference)						
Female	0.003	0.289	0.000	0.992	1.003	0.569-1.768

Age						
16-17 (Reference)						
18-19	0.084	0.371	0.051	0.822	1.087	0.526-2.249
Reinfection based on gender						
Male (Reference)						
Female	0.683	0.364	3.687	**0.009***	1.976	1.605-2.334
Reinfection based on age						
16-17 (Reference)						
18-19	0.648	0.355	3.688	**0.006***	1.911	1.556-2.266

[a]*B* is the coefficient for the constant
[b]Exp(B) is the exponentiation of the B coefficient, or the Odds Ratio
Sig is the p-value
*Results in bold are statistically significant (*p*-value <0.05)

Summary

There is a significant difference between initially infected adolescents that followed the retesting protocol versus reinfected adolescents that did not follow the retesting protocol. The results showed an association between reinfection with failure to follow the retesting protocol established by the Health Department. There is an association between reinfection and failure of sexual partners' treatment and there is an association between reinfection and no participation in the sexual orientation program offered by the Health Department. There is also an association between females and reinfection and ages 18-19 and reinfection. Recommendations and social implications are discussed in Chapter 5.

Chapter 5: Summary, Recommendations, and Conclusions

Summary

The purpose of this study was to examine the association between *Chlamydia trachomatis* reinfection and failure to receive antibiotic therapy and to follow the retesting protocol, failure of sexual partners to receive treatment, and failure to participate in the sexual orientation program about risk factors. I used secondary data from a historical prospective study from the Puerto Rico Department of Health. There were 9,022 adolescents 15 to 19 years old who had a positive chlamydia result since January 2008 through December 2012. Reinfection was analyzed in these adolescents.

The findings of the data analysis showed that there were significant differences between reinfected and initially infected adolescents. Alternative Hypothesis 1 established that there would be a significant association between *Chlamydia trachomatis* reinfection and failure to follow the retesting protocol established by the Department of Health. This hypothesis was accepted. Alternative Hypothesis 2 established that there would be a significant association between *Chlamydia trachomatis* reinfection and failure of sexual partners to receive treatment. This hypothesis was accepted. Alternative Hypothesis 3 established that there would be a significant association between reinfection and participation in the sexual orientation program about risk factors offered by the Department of Health during chlamydia treatment. This hypothesis was accepted. This chapter is a discussion of the hypotheses, the social implications of chlamydia infections and reinfections, and recommendations to reduce this STI.

Interpretation of the Findings

Research Question 1

The results of this study demonstrated that there was a statistically significant association in those reinfected adolescents that did not follow the retesting protocol of the Department of Health. The logistic regression model presented that reinfected adolescents analysis showed *OR*=1.243, 95% *CI* 1.089-2.930, and *p*-value 0.038. Thus, this hypothesis was accepted. Age (*p*-value 0.102) or gender (*p*-value 0.979) does not show stastically significant differences.

There were 736 males (13.9%) and 4,549 females (86.1%) that follow the retesting protocol. There were 471 males (13.8%) and 2,956 females (86.2%) initially infected that did not follow the retesting protocol. Reinfected that follow the retesting protocol were 13 males (12.2%) and 94 females (87.8%). Reinfected that did not follow the retesting protocol were 59 males (29.0%) and 144 females (71.0%). This finding is consistent with other researchers who stated that reinfections are common among middle and high school students (Gaydos et al., 2008). Adolescents that failed to follow the retesting protocol resulted reinfected during the follow up treatment.

The CDC (2010) guidelines for STD treatment established that women or men should be retested approximately 3 months, 6 months, 9 months, and 1 year after treatment to avoid the elevated risks for PID in women and other complications in men and women. Failure to follow the appropriate treatment and to develop behavioral modifications toward sexuality could result in reinfection (DiClemente et al., 2007).

Research Question 2

The results of this study demonstrated that there is a statistically significant association between reinfected adolescents whose sexual partners' did not receive treatment, showing that the *OR*=1.713, 95%, *CI* 0.761-2.024, and *p*-value 0.029.Thus, this hypothesis was accepted. However, age (*p*-value 0.182) or gender (*p*-value 0.544) does not provide stastically significant differences.

Adolescents are the most exposed group to *Chlamydia trachomatis* in United States (Porco et al., 2009). Post treatment infections occur because sexual partners have failed to be treated and have no notification for treatment. *Chlamydia trachomatis* reinfection in adolescents mostly occurs because even when they receive appropriate therapy and their sexual partners do not receive treatment (Batteiger et al., 2010; Hwang et al., 2005).

There were 698 males (12.8%) and 4,573 females (87.2%) initially infected whose sexual partners received treatment. There were 571 males (16.6%) and 2,870 females (83.4%) whose sexual partners did not receive treatment. Reinfected whose sexual partners received treatment were 10 males (7.9%) and 116 females (92.1%). Reinfected whose sexual partners did not receive treatment were 62 males (33.7%) and 122 females (66.3%). This information is indicative that reinfection occurs when sexual partners of the reinfected adolescents haven't been treated.

The CDC (2010) guidelines for STD treatment established that sexual partners' notification and treatment is necessary to reduce reinfection. This notification is the contact tracing that includes the process by which the public health authorities will

arrange the evaluation and treatment of the sexual partners. The direct health assistance should be accompanied by health counseling and appropriate services.

Research Question 3

The results of this study demonstrated that there is a statistically significant association between reinfected adolescents that did not participate in the sexual orientation program offered by the Department of Health. The logistic regression model presented that reinfected adolescents did not participate in the sexual orientation has an *OR*=1.243, 95% *CI* 0.762-2.026, *p*-value 0.034. Thus, this hypothesis was accepted. Age (*p*-value 0.0822) or gender (*p*-value 0.992) does not provide stastically significant differences.

There were 648 males (12.8%) and 4,423 females (87.2%) initially infected that participated in the sexual orientation program. There were 566 males (15.4%) and 3,075 females (84.6%) that did not participate in the sexual orientation program. Reinfected that participated in the sexual orientation program were 9 males (8.6%) and 96 females (91.4%). Reinfected that did not participate in the sexual orientation program were 56 males (27.3%) and 149 females (72.7%).

This is consistent with other researchers who showed that behavioral interventions integrating a change of behavior can significantly reduce unprotected sex, HIV and STI incidence (Patterson et al., 2008). Counseling and orientation are necessary to address the social and cultural conditions to identify barriers and solutions. According to DiClemente et al. (2007), familiar environment, parental monitoring, community, psychological states, self-esteem, and societal factors need attention. It is important to educate

adolescents and to help them to develop behavioral modifications toward sexuality. CDC (2010) guidelines for STD treatment emphasized and recommended that counseling about STDs is necessary to avoid recurrence.

Regarding reinfection patterns based on age and gender, there is a statistically significant association between reinfected females with reinfection (*OR*=1.976, 95% *CI* 1.605-2.334, *p*-value 0.009). Based on age, there is a statistically significant association between reinfected age group 18-19 and reinfection (*OR*=1.911, 95% *CI* 1.556-2.266, *p*-value 0.006).

Limitations of the Study

This research was conducted using existing data that were gathered from the STD MIS system program of the Puerto Rico Department of Health. The information collected was from adolescents 15-19 of age that resulted with a positive *Chlamydia trachomatis* screening between January 2008 and December 2012. The study was limited to initial infection and reinfection. Follow up treatment, sexual partners' treatment, and participation in the sexual orientation program were evaluated.

I did not consider how much adolescents learned about chlamydia during the orientation program, or if the Department of Health made sure that during the orientation the adolescents understood what chlamydia is and how it is transmitted. Neither did I consider learning barriers toward treatment and prevention. I did not investigate if sexual partners had other partners or if they were contacted to receive treatment.

Recommendations

Chlamydia trachomatis infections can cause serious morbidity and complications. I investigated some of the risks factors associated with chlamydia among Puerto Rican adolescents. Results showed that reinfection was associated with failure to follow the retesting protocol. Early detection and treatment are necessary to prevent health consequences. The CDC (2010) recommended sexual education since is the best way to avoid risky behavior and is cost effective. Preventive strategies can be based on CDC recommendations that emphasize the screening of all sexually active women age 25 or younger. This can be done as routine laboratory tests. Old women that present a risk factor for chlamydia infections, or that have a new or more sexual partner should also be screened. The use of condoms, consistently and correctly, can reduce the risk of chlamydia infections and its transmission.

The principal goal of *Chlamydia trachomatis* prevention program is to control the silent epidemic and consequences of the sequelae. Because chlamydia infection is common in adolescents and young adults, its prevention requires the support of health care providers, health departments, and school personnel. School based programs about sexual orientation can emphasize the sexual abstinence or to be in a monogamous relationship with a partner that is uninfected. Chlamydia can be diagnosed and treated easily because suitable laboratory tests exist for rapid screening and treatment.

According to the CDC (2010), repeat infections cause elevated risks of coinfections and other complications. Infected patients should be treated as well retested approximately after 3 months of the first infection to avoid the spreading of infection.

The screening is a critical component of the prevention program, because *Chlamydia trachomatis* infected persons are often asymptomatic. Health care providers as well the Department of Health should ensure the notification, evaluation, and treatment of sexual partners. The partners' referral is an important form to evaluate sexual exposure as well to encourage them to participate in the examination and treatment. The lack of responsibility of treating sexual partners remains the major problem for reinfection (CDC 2010). This is a particular problem for controlling *Chlamydia trachomatis* since reaching sexual partners and treating them prophylactically can eliminate the asymptomatic infection. Based on the results of this investigation, reinfection was associated with failure of sexual partners to receive treatment.

The screening of STIs, sexual education programs and partners referral require attention to minimize chlamydia transmission and sequelae. Interventions for sexual orientation and behavioral changes can promote the use of contraception and decreasing the number of sexual partners as well knowing the implications of having a STD. Schools programs may target adolescent population toward chlamydia and other STDs transmission and consequences.

Implications for Positive Social Change

Results showed the prevalence of reinfection of *Chlamydia trachomatis* in young Puerto Rican adolescents; reinfection occurs due to failure to follow the retesting protocol of the department of health, sexual partners are not informed nor treated, and there is a poor participation in the sexual orientation program. The data showed that women are more likely to participate more of the health department programs than men.

Results showed the need of a social positive change. It is important to talk with adolescents about chlamydia. It is important to promote a social approach to emphasize transmission, treatment, and sequelae. The awareness of this STD could reduce the impact of its transmission. I aimed to encourage healthy people. Early detection of chlamydia helps to protect people to develop other risk factors including coinfection with other diseases such HIV.

Conclusion

Chlamydia is the most common bacteria diagnosed worldwide. Its diagnosis rate is increasing yearly. Since this STD is mainly asymptomatic, screening, and treatment are necessary to detect and to reduce its transmission. I investigated reinfection among Puerto Rican adolescents between 2008-2012. Results were used to answer the research questions that established that failure to follow the retesting protocol, sexual partners' failure to be treated and no participation in the sexual orientation program were associated with reinfection. Chlamydia screening programs are necessary to control its transmission.

The CDC guidelines (2010) recommended the screening of all sexually active women age 25 or younger when visiting the gynecologist. High risk population, such as adolescents can be reached at school. This is an area needing further research. Schools may support this initiative, if it results cost effective. School based programs could be of STD counseling, education and behavioral interventions. Chlamydia is a preventable disease so with its management a reduction can be done. Education, counseling, and treatment are the key to decrease its prevalence.

References

Advocates for Youth. (2008). *Caribbean American HIV/AIDS awareness day*. Retrieved from http://www.advocatesforyouth.org/publications/451?task=view

Barbosa, M.J., Moherdaui, F., Pinto, V.M., Ribeiro, D., Cleuton, M., & Miranda, A.E. (2010). Prevalence of *Neisseria gonorrhoeae* and *Chlamydia trachomatis* infection in men attending STD clinics in Brazil. *Revista de Sociedade Brasileira de Medicina Tropical, 43*(5), 500-503.

Batteiger, B., Tu, W., Ofner, S., Van Der Pol, B., Stothard, D.R., Orr, D.P., … & Fortenberry, J.D. (2010). Repeated *Chlamydia trachomatis* genital infections in adolescent women. *Journal of Infectious Diseases, 1*(201), 42-51.

Blank, S., Schillinger, J., & Harbatkin, D. (2005). Lymphogranuloma venereum in industrialized world. *Lancet, 365*, 1607-1608.

Brunham, R., & Ladino, R. (2005). Immunology of Chlamydia infection: Implications for a *Chlamydia trachomatis* vaccine. *Nature Reviews Immunology, 5*, 149-161.

Buchholz, K., & Stephens, R. (2007). The Extracellular Signal-Regulated Kinase/Mitogen-Activated Protein Kinase Pathway Induces the Inflammatory Factor Interleukin-8 following *Chlamydia trachomatis* infection. *Infection and Immunity, 75*(12), 5924-5929.

Cajas, L., Mkocha, H., Munoz, B., Quinn, T., Gaydos, C., & West, S. (2011). Risk factors for ocular infection with *Chlamydia trachomatis* in children 6 months following mass treatment in Tanzania. *PLOS Neglected Tropical Diseases, 5*(3), 1-6.

Carlson, J., Whitmire, W., Crane, D., Wicke, L., Virtaneva, K., Studervant, D., …& Caldwell, D. (2008). The *Chlamydia trachomatis* plasmid is a transcriptional regulator of chromosomal genes and a virulent factor. *Infection and Immunity, 76*(6), 2273-2283.

Cates, J., Herndon, N., Schulz, S., & Darroch, J. (2004). *Our voices, our lives, our future: Youth and sexually transmitted diseases.* Chapel Hill, NC: University of North Carolina Chapel Hill.

Centers for Disease Control and Prevention. (2006a). *Sexually transmitted diseases treatment guidelines.* Retrieved from http://www.cdc.gov/std/treatment/2006/default.htm

Centers for Disease Control and Prevention. (2006b). *Sexually transmitted diseases treatment guidelines.* Retrieved from http://www.cdc.gov/std/treatment/2006/default.htm

Centers for Disease Control and Prevention. (2006c). HIV/AIDS. *Sexually transmitted diseases*. Retrieved from http://www.cdc.gov/hiv/resources/qa/definitions.htm

Centers for Disease Control and Prevention. (2008). *Chlamydia. Sexually transmitted diseases*. Retrieved from http://www.cdc.gov/std/chlamydia/default.htm

Centers for Disease Control and Prevention. (2010a). Genital herpes. *Sexually transmitted diseases*. Retrieved from http://www.cdc.gov/std/herpes/STDFact-Herpes.htm

Centers for Disease Control and Prevention. (2010b). Human Papilloma. *Sexually transmitted diseases*. Retrieved from http://www.cdc.gov/hpv/WhatIsHPV.html

Centers for Disease Control and Prevention. (2010c). *Sexually transmitted diseases treatment guidelines.* Retrieved from http://www.cdc.gov/std/treatment/2010/toc.htm

Centers for Disease Control and Prevention. (2012). *National estimates shows not enough young women tested for chlamydia.* Retrieved from http://www.cdc.gov/nchhstp/Newsroom/stdconference2012pressrelease.html

Chacko, M., Wiemann, C., Kozinetz, C., von Sternberg, K., Velasquez, M., Smith, P., & DiClemente, R. (2010). Efficacy of a motivational behavioral intervention to promote chlamydia and gonorrhea screening in young women: A randomized controlled trial. *Journal of Adolescent Health, 46*(2), 1-17.

Cone, R. (2014). Vaginal microbiota and sexually transmitted infections that may influence transmission of cell-associated HIV. *Journal of Infectious Diseases, 210 (Supple 3),* 616-621.

Corbeto, E.L., Lugo, R., Martro, E., Falguera, G., Ros, R., Avecilla, A.,…& Casabona, J. (2010). Epidemiological features and determinants for *Chlamydia trachomatis* infection among women in Catalonia, Spain. *International Journal of STD & AIDS, 21*(10), 718-722.

Department of Health of Puerto Rico. (2006). STD treatment guidelines from the Health Department of Puerto Rico. *STD/HIV surveillance office*.

Department of Health of Puerto Rico. (2010). STD treatment guidelines from the Health Department of Puerto Rico. *STD/HIV surveillance office*.

Department of Health of Puerto Rico. (2012). *Chlamydia* cases per year, age and gender in Puerto Rico (2000–2011). *STD/HIV surveillance office*.

Department of Health of Puerto Rico. (2013). *Chlamydia* cases per year, age and gender in Puerto Rico (2000–2012). *STD/HIV surveillance office*.

DiClemente, R., Salazar, L., & Crosby, R. (2007). A review of STD/HIV preventive interventions for adolescents sustaining effects using an ecological approach. *Journal of Pediatric Psychology, 32*(8), 888-906.

Gaydos, C.A., Wright, C., Wood, B., Waterfield, G., Hobson, S., & Quinn, T.C. (2008). *Chlamydia trachomatis* reinfection rates among female adolescents seeking rescreening in school-based health centers. *Sexually Transmitted Diseases, 35*(3), 233-237.

Gen-Probe. (2012) Aptima Combo 2 Assay: *Chlamydia trachomatis & Neiserria gonorrhea.* Retrieved from http://www.gen-probe.com/pdfs/pi/501798-EN-RevC.pdf

Ginige, S., Fairley, C., Hocking, J., Bowden, F., & Chen, M. (2007). Interventions for increasing *Chlamydia* screening in primary care: a review. *BMC Public Health, 7*(95), 1-6.

Gottlieb, S., Brunham, R., Byrne, G., Martin, D., Xu, F., & Berman, S. (2010). Introduction: The natural history and immunobiology of *Chlamydia trachomatis* genital infection and Implications for chlamydia control. *Journal of Infectious Diseases, 201*(Suppl. 2), 85-87.

Gray, R., Beagley, K., Timms, P., & Wilson, D. (2009). Modeling the impact of potential vaccines on epidemics of sexually transmitted chlamydia trachomatis infection. *Journal of Infectious Diseases, 199*(11), 1680-1688.

Heijne, J., Althaus, C., Herzog, S., Kretzschmar, M., & Low, N. (2010). The role of reinfection and partner notification in the efficacy of chlamydia screening programs. *Journal of Infectious Diseases, 203*(3), 372-377.

Hwang, L.Y., Tebb, K.P., Shafer, M.B., & Plantell, R. (2005). Examination of the treatment and follow up care for adolescents who test positive for *Chlamydia trachomatis* infection. *Archives of Pediatrics & Adolescents Medicine, 159*, 1162-1166.

Joyee, A.G., Thyagarajan, S.P., Reddy, E.V., Venkatesan, C., & Ganapathy, M. (2005). Genital chlamydial infection in STD patients: Its relation to HIV infection. *Indian Journal of Medical Microbiology, 23*, 37-40.

Khan, A., Fortenberry, D., Juliar, B., Tu, W., Orr, D., & Batteiger, B. (2005). The prevalence of chlamydia, gonorrhea, and trichomonas in sexual partnerships: Implications for partner notification and treatment. *Sexually Transmitted Diseases, 32*(4), 260-264.

Klavs, I., Rodrigues, L., Welling, K., Kese, D., & Hayes, R. (2004). Prevalence of genital *Chlamydia trachomatis* infection in the general population of Slovenia: serious gaps in control. *Sexually Transmitted Infections, 80*, 121-123.

Kretzschmar, M., & Dietz, K. (1998). The effect of pair formation and variable infectivity on the spread of an infection without recovery. *Math Bioscience, 148,* 83-113.

Lee, J., Jung, S., Kwon, D., Jung, M., & Park, B. (2010). Condom use and prevalence of genital *Chlamydia trachomatis* among the Korean female sex workers. *Epidemiology and Health, 32,* 1-5.

LexJuris of Puerto Rico. (2007). *Law no. 193 of 2007*. Retrieved from http://www.lexjuris.com/LEXLEX/Leyes2007/lex12007193.htm

Marangoni, A., Foschi, C., Nardini, P., D'Antuono, A., Banzola, N., Di Francesco, A., …Cevenini, R. (2012). *Chlamydia trachomatis* serovar distribution and other sexually transmitted coinfections in subjects attending an STD outpatients clinic in Italy. *New Microbiologica, 35,* 215-219.

Mariotti, S., Pascolini, D., & Rose-Nussbaumer, J. (2009). Trachoma: Global magnitude of a preventable cause of blindness. *British Journal of Ophthalmology, 93,* 563-568.

Marrazzo, J., & Martin, D. (2007). Management of women with cervicitis. *Clinical Infectious Diseases, 3*(4), 102-110.

Molano, M., Meijer, C., Weiderpass, E., Arslan, A., Posso, H., …van den Brule, A. (2005). The natural course of *Chlamydia trachomatis* infection in asymptomatic Colombian women: a 5-year follow up study. *Journal of Infectious Diseases, 191,* 907-916.

Morrison, S. G., & Morrison, R. P. (2005). A predominant role for antibody in acquired immunity to chlamydial genital tract reinfection. *Journal of Immunology, 175*, 7536-7542.

National Statistical Service. Retrieved from http://www.nss.gov.au/nss/home.NSF/pages/©+Copyright?OpenDocument

Novak, D., & Karlsson, R. (2006). Simplifying chlamydia testing: an innovative *Chlamydia trachomatis* testing approach using the internet and a home sampling strategy: population based study. *Sexually Transmitted Infections, 82*(2), 142-147.

Nusbaum, M., Wallace, R., Slatt, L., & Kondrad, E. (2004). Sexually transmitted infections and increased risk of co-infection with Human Immunodeficiency Virus. *Journal of the American Osteopathic Association, 104*(12), 527-535.

Oakeshott, P., Kerry, S., Aghaizu, A., Atherton, H., Hay, S., Taylor, D., …Hay, P. (2010). Randomized controlled trial of screening for *Chlamydia trachomatis* to prevent pelvic inflammatory disease: the POPI (prevention of pelvic infection) trial. *BMJ, 340*, 1-7.

Parks, K., Dixon, P., Richey, C., & Hook, E. (1997). Spontaneous clearance of *Chlamydia trachomatis* infection in untreated patients. *Sexually Transmitted Diseases, 24*(4), 229-235.

Patterson, T., Mausbach, B., Lozada, R., Staines, H., Semple, S., Fraga, M., …Strathdee, S. (2008). Efficacy of a brief behavioral intervention to promote condom use among female sex workers in Tijuana and Ciudad Juarez, Mexico. *American Journal of Public Health, 98*(11), 2051-2057.

Physician Desk Reference. (2010). *Azithromycin*. Retrieved from http://www.pdr.net/druginformation/FDAMonographsInfo.aspx?MonographID=1098

Pedlow, C., & Carey, M. (2003). HIV sexual risk-reduction interventions for youth: A review and methodological critique of randomized controlled trials. *Behavior Modification, 27*(2), 135-190.

Porco, T., Gebre, T., Ayele, B., House, J., Keenan, J., Zhou, A.,…Lietman, T. (2009). Effect of mass distribution of Azithromycin for Trachoma control on overall mortality in Ethiopian children. A randomized trial. *Journal of the American Medical Association, 302*(9), 962-968.

Radcliffe, K., Ahmad, S., Gilleran, G., & Ross, J. (2001). Demographic and behavioral profile of adults infected with *Chlamydia*: a case-control study. *Sexually Transmitted Infections, 77*, 265-270.

Rekart, M., & Brunham, R. (2008). Epidemiology of chlamydial infection: Are we losing ground? *Sexually Transmitted Infections, 84*, 87-91.

Robin, L., Dittus, P., Whitaker, D., Crosby, R., Ethier, K., Mezoff, J., …Pappas, K. (2004). Behavioral interventions to reduce incidence of HIV, STD, and pregnancy among adolescents: A decade in review. *Journal of Adolescent Health, 34*(1), 3-26.

Safaeian, M., Quint, K., Schiffman, M., Rodriguez, A.C., Wacholder, S., Herrero, R.,… Burk, R.D. (2010). *Chlamydia trachomatis* and risk of prevalent and incident

cervical premalignancy in a population-based cohort. *Journal of the National Cancer Institute, 102*(23), 1794-804.

Simms, I., Warburton, F., & Westrom, L. (2003). Diagnosis of pelvic inflammatory disease: Time for a rethink. *Sexually Transmitted Infections, 79*(6), 491-494.

Steiner, A., Haller, D., Ellger, B., Sebo, P., Gaspoz, J., & Wolff, H. (2010). *Chlamydia trachomatis* infection in a Swiss prison: A cross sectional study. *Swiss Medical Weekly, 140*, w13126.

Swanson, K., Taylor, L., Frank, S., Sturdevant, G., Fischer, E., Carlson, J., Whitmire, W., & Caldwell, H. (2009). *Chlamydia trachomatis* Polymorphic membrane protein D is an oligomeric autotransporter with a higher-order structure. *Infectious Immunology, 77*(1), 508-516.

Tan, C., Hsia, R., Shou, H., Carrasco, J., Rank, R., & Bavoli, P. (2010). Variable expression of surface-exposed polymorphic membrane proteins in in vitro grown *Chlamydia trachomatis. Cellular Microbiology, 12*(2), 174-187.

Trelle, S., Shang, A., Nartey, L., Cassell, J., & Low, N. (2007). Improved effectiveness of partner notification for patients with sexually transmitted infections: systematic review. *BMJ, 334*, 354-357.

Trentmann, O., Horn, M., van Scheltinga, A., & Haferkamp, I. (2007). Enlightening energy parasitism by analysis of an ATP/ADP transporter from chlamydiae. *Plos Biology, 5*(9), 231. doi: 10.1371/journal.pbio.0050231

Turner, K., Adams, E., Grant, A., Macleod, J., Bell, G., Clarke, J., & Horner, P. (2011). Costs and cost effectiveness of different strategies for *chlamydia*

screening and partner notification: An economic and mathematical modeling study. *BMJ, 4*, 342, doi: 10.1136/bmj.c7250

US Department of Health and Human Services. (2007). *Reproduction and sexual health*. Retrieved from http://health.nih.gov/category/ReproductionandSexualHealth

Vonck, R., Darville, T., O'Connell, C.M., & Jerse, A. (2011). Chlamydial infection increases gonococcal colonization in a novel murine coinfection model. *Infection and Immunity, 79*(4), 1566-1577.

Weinstock, H., Berman, S., & Cates, W. (2004). Sexually transmitted diseases among American youth: incidence and prevalence estimates, 2000. *Perspectives on Sexual and Reproductive Health, 36*(1), 6-10.

World Health Organization (WHO). (2005). *Sexually transmitted and other reproductive tract infections: a guide to essential practice.* Retrieved March 19, 2010, from, http://www.who.int/entity/reproductivehealth/publications/rtis/9241592656/en/index.html.

Appendix A: Data Use Agreement

COMMONWEALTH OF PUERTO RICO
DEPARTMENT OF HEALTH
SAN JUAN, PUERTO RICO

DATA USE AGREEMENT

APPEAR

FOR THE FIRST PARTY: THE PUERTO RICO DEPARTMENT OF HEALTH, a government agency organized and existing under the laws of the Commonwealth of Puerto Rico, herein represented by it's the Secretary of Health, **ANA C. RIUS ARMENDARIS, MD**, of legal age, a medical doctor, resident of Guaynabo, Puerto Rico, or represented by the Acting Undersecretary of Health, **GREDUVEL DURAN GUZMAN, MD, MPH**, of legal age, married and a resident of San Juan, Puerto Rico, who appears in representation of the Secretary of Health and is duly authorized to sign this Agreement by the delegation made on by the Secretary of Health in accordance with Law No. 81 of March 14, 1912, hereinafter referred to as the "**DATA PROVIDER**".

FOR THE SECOND PARTY: FLAVIA ROSADO FERNANDEZ, of legal age, a medical technologist, student of Walden University and resident of Canóvanas, Puerto Rico, hereinafter referred to as the "**DATA RECIPIENT**".

The purpose of this Data Use Agreement is to conduct a research about the correlation between *Chlamydia trachomatis* re-infection in adolescents 15 to 19 years old who live in Puerto Rico and *Chlamydia trachomatis*. The research will be based on data available on the STD MIS official software program. The study population will be adolescents between 15 and 19 years old who resulted positive for *Chlamydia trachomatis* between January 2008 and December 2012. The Department of Health Puerto Rico, STD/HIV Prevention Department, will provide the requested data to the **DATA RECIPIENT.**

The parties hereto agree as follows:

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the "HIPAA Regulations" codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. The Health Department of Puerto Rico, STD/HIV Prevention Department shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations.

3. Data Fields in the LDS. No direct identifiers such as names may be included in the Limited Data Set (LDS). In preparing the LDS, The Health Department of Puerto

Rico, STD/HIV Prevention Department shall include the data fields specified as follows, which are the minimum necessary to accomplish the research:

- Patients results on the STD MIS official software program about adolescents 15 to 19 years old who resulted with a positive *Chlamydia trachomatis* screening test between January 2008 and December 2012.

- Data will be limited to unique client number identifier, age, sex, date of initial positive *Chlamydia* test, antibiotic treatment, follow up treatment, result of follow up, history of re-infections, notification and treatment of sexual partners and documentation of the participation of the orientation program about risk factors; number of sex partners during *Chlamydia* treatment and condom use.

4. Responsibilities of Data Recipient. Data Recipient agrees to:

   - Use or disclose the LDS only as permitted by this Agreement or as required by law;

   - Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

   - Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

   - Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

   - Not use the information in the LDS to identify or contact the individuals who are data subjects.

5. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for the research about "the correlation between *Chlamydia trachomatis* re-infection in adolescents 15 to 19 years old who live in Puerto Rico and failure of partners' treatment".

6. Term and Termination.

   - Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

   - Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

- Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

- For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

- Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

7. Miscellaneous.

- Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

- Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

- No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

- Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

- Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

8. The data requested will be available after the Walden University IRB approval in relation to the proposed PhD dissertation work.

9. After completion and approval of the proposed PhD dissertation work, a copy will be submitted to the PRDOH to be available in its library for educational and research purposes.

2014 DS0631

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER:

ANA C. RIUS ARMENDARIZ, MD
SECRETARY
PRDOH
660-43-7470

REVISADO POR:
Wendy Sostre
26 FEB 2014
FECHA
OFICINA
ASESORES LEGALES

DATA RECIPIENT:

FLAVIA ROSADO FERNANDEZ
License number: 1772252 S.S. 581-89-4666
Address: Las Haciendas de Canovanas, Camino Real 15144
Canovanas, Puerto Rico 00729
Telephone: 939-969-0745
E-mail: rosadofla@gmail.com
flavia.rosado@waldenu.edu

This contract was presented for registration with the Puerto Rico comptrollers oficce, on this date 12 MARZO 2014.

Appendix B: Puerto Rico's STDs Screening Form

Sys. Gen. Rec #_____ Acct (Visit) #_____

PREVENCION

PUERTO RICO DEPARTMENT OF HEALTH

☐ **Instituto Laboratorio Salud Oscar Costa Mandry**	☐ **Laboratorio ETS/VIH/SIDA Ponce**	☐ **Laboratorio Inmunología y ETS**
Edif. A 2do Piso Bo. Monacillos Rio Piedras, PR 00923 Lic.# 1 CLIA # 40D0672312	Antiguo Hospital Regional de Ponce Carr. 14 Bo. Machuelo Ponce, PR 00733-0550 Lic. # 705 CLIA # 40D0862228	2do. Piso Antigua Casa de Salud Centro Médico Mayagüez Mayagüez, PR 00682 Lic. # 822 CLIA # 40D0690924

Patient Name: _____ (1st Last Name) _____ (2nd Last name) _____ (First Name) _____ (Initial)

Physical Address: _____ Date of Birth: ☐☐/☐☐/☐☐

_____ Zip Code: ☐☐☐☐☐-☐☐☐☐ M M D D Y Y

HIV Form #: ☐☐☐☐☐☐☐☐☐☒☒☒☒☒ Manual Rec #: _____ Gender: ☐ Male ☐ Female

County FIPS: _____ State FIP Code : 72 SS #:☐☐☐-☐☐-☐☐☐☐ Age: ___ years ___ months

Facility Identification:
- **(Provider)**

☐☐☐☐ _____

Staff Identification:
- **(MD, DIS, Nurse)**

☐☐☐☐☐ _____

☐ STARHS Consent

Race:
☐ 1 American Indian or Alaskan Native
☐ 2 Asian
☐ 3 Black or African American
☐ 4 Native Hawaiian / Other Pacific Island
☐ 5 White
☐ 6 Other ☐ 7 Unknown / Not Reported

Ethnicity:
☐ 1 Hispanic ☐ 2 Non-Hispanic ☐ 9 Unknown

Local Code: ☐ 4 Virgin Islands
☐ 1 Puerto Rican ☐ 5 North American
☐ 2 Dominican ☐ 6 Canadian ☐ 8 Other
☐ 3 Cuban ☐ 7 Spaniard ☐ 9 Unknown

Reason for Test/Visit:
☐ 1 Routine Exam/Screening Test
☐ 2 Symptoms/Signs
☐ 3 Contact to STD
☐ 4 Prenatal/Pregnant
☐ 5 Contraceptive Services
☐ 6 Follow up / T.O.C.
☐ 7 Marriage Certificate
☐ 8 Health Certificate
☐ 9 Other/Unknown

Date of Specimen Collection: ☐☐/☐☐/☐☐ (M M D D Y Y)

Hour of Specimen Collection: ___☐ AM ☐ PM

Taken by: _____ Physician: _____

Health Care Provider Type:
☐ 1 Family Planning
☐ 2 STD Clinic
☐ 3 Prenatal Clinic
☐ 4 Health Maintenance Organization (HMO)
☐ 5 Adolescent Health Clinic
☐ 6 Detention Center
☐ 7 Migrant Health Clinic
☐ 8 Indian Health Center
☐ 9 College Health Center
☐ 10 Community Health Center
☐ 11 Private Physician
☐ 12 CBO
☐ 13 Other Health Provider

Laboratory Test Type:
☐ 1 VDRL ☐ 2 EIA for Syphilis
☐ 3 TP-PA or Treponemal Test ____ If Necessary _____ Necessary
☐ 4 Viral Load ☐ HIV ☐ HCV
☐ 5 Genotype ☐ HIV ☐ HCV
☐ 6 PCR-DNA
☐ 7 HIV ☐ Elisa ☐ Western Blot ☐ Oral Fluid
☐ Rapid Test (Blood) ☐ Rapid Test (Oral Fluid)
☐ 8 Flow Citometry – CD4 / CD8
☐ 9 CBC
☐ 10 Chlamydia (CT) ☐ 11 Gonorrhoeae (GC) ☐ 12 GC Culture

☐ Urethral	☐ Urethral	☐ Urethral
☐ Endocervical	☐ Endocervical	☐ Cervical
☐ Urine	☐ Urine	☐ Rectal
☐ Other	☐ Other	☐ Oral

Patient Risk History

	YES	NO	Unknown
1- Two (2) or more sex partners past 90 days	☐	☐	☐
2- New sex partner past 90 days	☐	☐	☐
3- Sex with symptomatic partner, past 90 days	☐	☐	☐
4- Positive Chlamydia last 12 months	☐	☐	☐
5- Positive Gonorrhoeae last 12 months	☐	☐	☐
6- Positive Syphilis last 12 months	☐	☐	☐
7- Any other STD last 12 months	☐	☐	☐

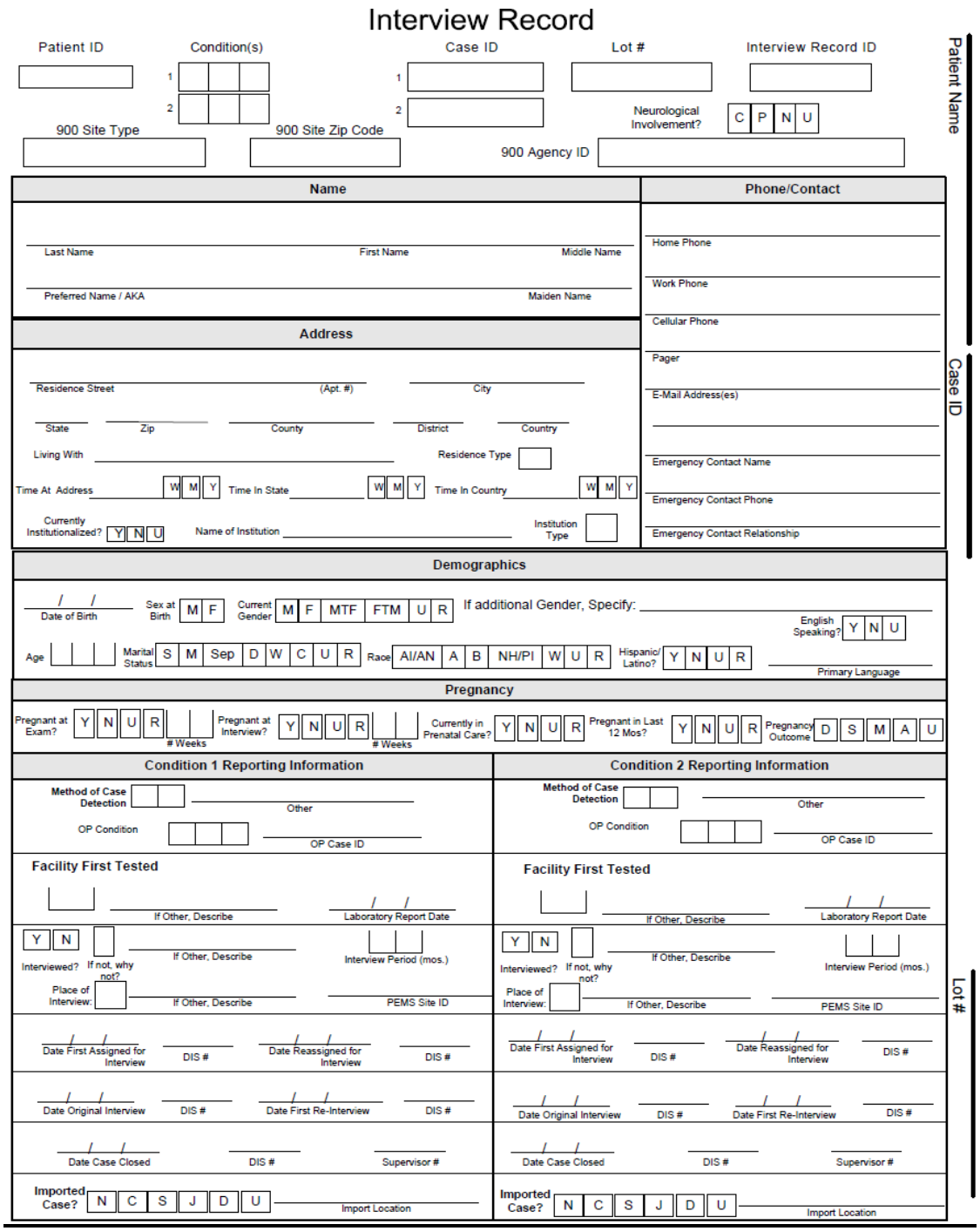
Which? ☐ Condiloma ☐ HPV ☐ Trichomonas ☐ Herpes ☐ Other _____

8- IV Drug User ☐ Yes ☐ No
9- Always used condom ☐ Yes ☐ No
10- Sex with ☐ Male ☐ Female ☐ Both
11- Pregnant at this visit ☐ Yes ___ weeks ☐ No ☐ Unknown
12- Recently treated for STD ☐ Last 2 wks ☐ Last 4 wks ☐ Last 10 wks

1.A Clinical Findings on Physical Exam

☐ 1 Normal Appearance ☐ 2 Mucopurulence ☐ Cervical ☐ Urethral ☐ Eye ☐ 3 Friable Cervix (bleeds on touch) ☐ 10 None
☐ 4 Cervical Motion / Tenderness ☐ 5 PID ☐ 6 Cervicitis ☐ 7 Urethritis ☐ 8 Ectopy ☐ 9 Epididymitis ☐ 11 Other _____

Appendix C: Puerto Rico's STDs Interview Record



Page 2

Case ID

RISK FACTORS

Y-Yes, Anal or Vaginal Intercourse (with or without Oral Sex) O-Yes, Oral Sex Only U-Unspecified Type of Sex
N-No R-Refused to Answer D-Did Not Ask

Within the past 12 months has the patient:

1. Had sex with a male?
2. Had sex with a female?
3. Had sex with a transgender person?
4. Had sex with an anonymous partner?
5. Had sex without using a condom?
6. Had sex while intoxicated and/or high on drugs?
7. Exchanged drugs/money for sex?
8. **[Females only]** Had sex with a person who is known to her to be an MSM?
9. Had sex with a person known to him/her to be an IDU?

Y- Yes N-No R-Refused to Answer D-Did Not Ask

Within the past 12 months has the patient: Y/N/R/D

10. Been incarcerated?
11. Engaged in injection drug use?
12. Shared injection drug equipment?

13. During the past 12 months, which of the following injection or non-injection drugs have been used? (Y/N/R/D)

- None
- Crack
- Cocaine
- Heroin
- Methamphetamines
- Nitrates/Poppers
- Erectile dysfunction medications (e.g., Viagra)
- Other, specify: _____

14. Other Risk, Specify: _____

Social History

Places Met Partners

Type | Name

Did not ask

Refused to answer

Places Had Sex

Type | Name

Did not ask

Refused to answer

Partners in Last 12 Months

Female | Unknown U | Refused R

Male | Unknown U | Refused R

Transgender | Unknown U | Refused R

Interview Period Partners

Condition 1	Unknown	Refused	Condition 2	Unknown	Refused
Female	U	R	Female	U	R
Male	U	R	Male	U	R
Transgender	U	R	Transgender	U	R

Additional Social History Comments

Local Use: A B C D E F G H I J K L

Page 3

Case ID

STD Testing

Date Collected	Provider	Test	Specimen Source	Qualitative Result	Quantitative Result
/ /				P N I U Q C	1:
/ /				P N I U Q C	1:
/ /				P N I U Q C	1:
/ /				P N I U Q C	1:

HIV Testing

Tested for HIV at this event? Y N U R Not Asked

Previously Tested for HIV? Y N U R Not Asked

Self Reported HIV Test Result: 01 02 03 04 66 77 99

Date of Self Reported Test: / /

Date Collected	Provider	Test	Specimen Source	Qualitative Result	Provider Confirmed
/ /				P N I U Q C	
/ /				P N I U Q C	
/ /				P N I U Q C	

Signs and Symptoms

	Signs/ Symptoms	Earliest Observation Date	Anatomic Site	Clinician Observed?	Patient Described?	Duration (Days)
1.		/ /				
2.		/ /				
3.		/ /				

If Other, Please Describe:

STD History

Previous STD History? Y N U R

	Condition	Dx Date (mm/yyyy)	Rx Date (mm/yyyy)	Confirmed?
1.		/	/	
2.		/	/	
3.		/	/	

STD/HIV Treatment/Counseling

Treatment Date	Provider	Drug and Dosage
/ /		
/ /		
/ /		

Treatment Comments:

Incidental Antibiotic Treatment in Last 12 Months? Y N U

Rx Date (mm/yyyy)	Drug/Dosage/Duration	Condition
/		
/		

Anti-Retroviral Therapy for Diagnosed HIV Infection? In Last 12 Months? Y N U R Ever? Y N U R

Results Provided: Y N

900+ Only: **Referred to Medical Care:** Y N **If Yes, did Client Attend First Appt.:**

Page 4

Case ID

Partner, Social Contact, & Associate Information

1	Last Name		First Name		AKA		Jurisdiction
	Referral Basis	First Exposure / /	Freq.	Last Exposure / /	Gender M F T U R	Pregnant Y N U R	Spouse Y N U R

Condition 1	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP
Condition 2	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP

2	Last Name		First Name		AKA		Jurisdiction
	Referral Basis	First Exposure / /	Freq.	Last Exposure / /	Gender M F T U R	Pregnant Y N U R	Spouse Y N U R

Condition 1	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP
Condition 2	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP

3	Last Name		First Name		AKA		Jurisdiction
	Referral Basis	First Exposure / /	Freq.	Last Exposure / /	Gender M F T U R	Pregnant Y N U R	Spouse Y N U R

Condition 1	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP
Condition 2	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP

4	Last Name		First Name		AKA		Jurisdiction
	Referral Basis	First Exposure / /	Freq.	Last Exposure / /	Gender M F T U R	Pregnant Y N U R	Spouse Y N U R

Condition 1	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP
Condition 2	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP

5	Last Name		First Name		AKA		Jurisdiction
	Referral Basis	First Exposure / /	Freq.	Last Exposure / /	Gender M F T U R	Pregnant Y N U R	Spouse Y N U R

Condition 1	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP
Condition 2	/ / Ix Date	/ / Init. Date	Ix DIS #	Ix Type	Type Ref.	FR#	Dispo	/ / Dispo Date	Cond.	DIS #	SO/SP

Marginal Partners, Social Contacts, & Associates

	Name	Sex	Age	Race	Height	Weight	Hair	Exposure	Locating Information
1									
2									
3									
4									
5									

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Curriculum Vitae

FLAVIA ROSADO

Las Haciendas de Canovanas
Email: Rosadofla@gmail.com

Education:

Currently enrolled in a PhD in Public Health **(At present)**
Walden University, Minneapolis, Minnesota

Master Degree in Medical Technology **(May 2004)**
Biochemistry Concentration
Interamerican University of Puerto Rico, Metro Campus

Post Graduate Certificate in Medical Technology **(February 1998)**
Interamerican University of Puerto Rico, Metro Campus

Bachelor Degree in Biology **(December 1996)**
Microbiology Concentration
Interamerican University of Puerto Rico, Metro Campus

Professional Experience:

General and Technical Laboratory Supervisor, Laboratorios Clinicos BioTech I, II, and III, Carolina and Rio Grande, Puerto Rico **(2006 to Present)**
Performing Quality Control and Quality Assurance Procedures. Conducting hematology, chemistry, bacteriology, virology and immunology tests for prevention and diagnosis of diseases. Analyses on blood, plasma and serum, urine, sputum, and stool, cerebrospinal fluid, synovial and pericardial specimens.

Quality Assurance Investigator Specialist II, Wyeth Pharmaceutical Inc., Carolina, Puerto Rico **(2002 - 2006)**

Conducting Chemistry, Microbiology, and Research investigations for parenteral products in compliance with the US Food and Drug Administration (FDA) guidance.

Quality Assurance Product Coordinator, Wyeth Pharmaceutical Inc., Carolina, Puerto Rico **(2000 - 2002)**
Parenteral Product disposition such as raw material, intermediate product, chemotherapeutics and antibiotics.

Quality Control Microbiology Analyst, Wyeth Pharmaceutical Inc., Carolina, Puerto Rico **(1998 - 2000)**
Performing environmental testing in aseptic and control areas for parenteral and antibiotic products. Analyzing product for endotoxin. Conducting growth promoting test for culture media.

Travel and Seminars:

Walden University Academic Residencies:
-August 2008, Madrid, Spain
-January 2008, Dallas, Texas
-June 2007, Liverpool, United Kingdom
-December 2006, Lansdowne, Virginia
Connecting with faculty members. Enhancing writing, critical thinking and research skills.

VWR International Sales Program, Wyeth Pharma, Pearl River, New York **(December 2005)**

Laboratory Management System Improvement, Wyeth Corporate, Radnor, Pennsylvania **(August 2002)**

Computer Skills:
-Microsoft Word
-Excel
-Power Point
-Publisher
-Track Wise Program
-Mini Tab Program