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Chlamydia Trachomatis in Non-Specific Urethritis

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1. Introduction

The Chlamydiae belongs to the order Chlamydiales with one family Chlamydiaceae one genus *Chlamydia* and three species that infect man *Chlamydia trachomatis, Chlamydia psittacci* and *Chlamydia pneumoniae* (Thylefers et al. 1987; Zhang and Stephens, 1992; Peeling et al. 1998). Chlamydiae were first cultured in the 1950s. The wide spread importance and frequencies of genital tract *Chlamydia* infections were first appreciated in the 1960s. *Chlamydia* were first thought to be viruses and were referred to as large viruses (Peeling et al. 1998). They look like bacteria by having cell wall which lack muramunic acid and are like viruses by being filterable (Koh et al. 2002).

Chlamydia includes organisms previously called the psittacisis- lymphogranuloma venereum-trachoma group (PLT organisms) or the trachoma-inclusion conjunctivitis (TRIC organisms). *Chlamydia* are non-motile, coccoid looking like gram-negative bacteria ranging in size from 0.2 to 1.5µ. For years *Chlamydia* were considered to be viruses but they are now considered to be a special kind of Gram negative bacteria. They also differ from viruses by containing both DNA and RNA (Strickland, 1994). They can only reproduce in the cytoplasmic vesicle of the host cell by a unique developmental life cycle involving the formation of elementary and reticulate bodies (Miyuashita et al. 1993).

Chlamydia are rapidly inactivated by heat. They lose their infectivity completely after 10 minutes at 60^{o}C and partly after 3 to 12 hours at 37^{o}C. They can maintain infectivity for years at 5^{o}C and 7^{o}C. During the process of freeze-drying, much of the infectivity is lost, but successfully lyophylised preparations are stable for a long period. Chlamydiae are rapidly inactivated in the presence of phenols (Koh et al. 2002).

Chlamydia psittaci is a diverse species that has poorly been characterized. Strains that infect psittacine birds seem to differ from those that infect poultry. Several mammals and marsupials have species-specific strains (Prescott et al. 1999). Generally humans are not susceptible to infection with most mammalian strains of *Chlamydia psittaci.* A major problem with *Chlamydia psittaci* is that it is zoonotic in nature. In birds *Chlamydia psittaci* may present as an upper respiratory infection with nasal and ocular discharge, diarrhea or a combination of both. In some cases birds may be infected with no sign. These cases are of importance because birds are carriers and shed the organism. Psittacosis in humans can result in mild and severe disease. In several cases, humans that are infected often have severe fever with night sweats leading to pneumonia. It is very important that pet birds owners and handlers

of poultry become aware of this disease in order to prevent outbreak (McPhee and Harrignton, 1987).

The first *Chlamydia pneumoniae* case which was formally called Taiwanese acute respiratory (TWAR) agent strain was first cultured in 1960s in chick embryo sac but was thought to be a member of the species *Chlamydia psittaci. Chlamydia pneumoniae* as an important respiratory pathogen has led to the reappraisal of our concept chlamydia respiratory infections (Grayston et al. 1990 and Grayston, 1992). *Chlamydia pneumoniae* is mainly unique to man and in man infection may vary from mild to severe cases. Result of surveys indicated that sub clinical chlamydial infections occur, which often remains undiagnosed because of their similarity to other respiratory infections. The onset of pneumonia may be sudden with chills, fever, anorexia, sore throat, severe headache and photophobia or the disease may develop gradually. In severe cases, nausea, vomiting and diarrhea or constipation may be observed. The fever remains high in severe cases while it may fall to normal within a week in milder cases. Cyanoids and low blood pressure may be observed. Generally, *Chlamydia pneumoniae* causes pneumonia, bronchitis and pharyngitis in school children (Karvonem et al. 1992). Some physicians have reported *Chlamydia pneumoniae* infection in patients with asthma.

A mention of *Chlamydia* is often referred to a disease caused by *Chlamydia trachomatis*. *Chlamydia trachomatis* infections are mainly spread through sexual contact and most times neonatal. This includes from penis to vagina, penis to rectum and also from mother to child during birth (Lin et al. 1992) the sexually transmitted disease usually comes with no clear-cut symptoms. *Chlamydia trachomatis* threatens to cause reproductive damage and infertility in as many as 3 to 5 million people in America alone each year (Lin et al. 1992). This makes *Chlamydia trachomatis* the most prevalent sexually transmitted diseases worldwide (Macaulay et al. 1990; Azenabor and Eghafona, 1997; Azenabor et al. 2007). Due to its latent infection *Chlamydia trachomatis* is rarely diagnosed especially in developing countries, which is why this study sought to establish the prevalence of *Chlamydia trachomatis* in non-specific urethritis. *Chlamydia trachomatis* still remains ahead of gonorrhea and syphilis in the list of most commonly transmitted sexual disease. *Chlamydia trachomatis* may result in urethritis, epididymitis, cervicitis, pelvic inflammatory disease (PID) and other conditions. Men and women infected with *Chlamydia* may have discharge from the penis or vagina and may notice burning urination. Infections in the rectum may cause problems or pains. In many instances, both men and women will not notice any symptoms (50% of women and 25% of men). If symptoms do occur, they usually show up within 1 to 2 weeks after been exposed. A person can be infected at any age, the age group been mostly affected being 15-19 years of age but Okoror et al. (2008) reported age group 30-36 being mostly exposed but this they attributed to the fact that they sampled only women of child bearing age and their spouses. Okoror et al. (2007) also reported that *Chlamydia trachomatis* infect all age groups. The discrepancies in their reports would have been because of difference in the populations sampled. Johnson et al. (Johnson et al. 1994) reported that the adolescents are at high risk. In a study by Agbonlahor et al. (2009) in North West zone of Nigeria, 75% of the total samples cultured were positive to *Chlamydia trachomatis* although the diseases were not stratified. They also reported that most of the subjects whose samples were positive had difficulty urinating and that most of the positive women had symptoms looking like that of PID as confirmed by a clinician. They also confirmed the endemicity of *Chlamydia trachomatis* in the population studied. However, there could be prevalence of *Chlamydia trachomatis* in asymptomatic individuals. Baud et al. (2008) reported low prevalence of *Chlamydia*

trachomatis in asymptomatic Swiss males. They also reported that the prevalence of *Chlamydia trachomatis* is low compared to other countries.

Urinary tract infections (UTI) could be defined as the persistent presence within the urinary tract of actively multiplying microorganisms. UTI implies both microbial colonization of the urine and invasion of the lower or upper urinary tract by microorganisms (Reld and Spied, 1987). It is an infection with more than 100,000 organisms per millilitres in the mid-stream samples of urine (Macleod *et al.,* 1984).

Urinary tract infection is the most common disease of the urinary tract and it is a major cause of morbidity in both the hospital and the community (Hannan *et al.,* 1993). The most common cause of UTI are bacteria, and less often viruses, yeasts or other intracellular microorganisms (Cattell, 1985). According to Bohnson (1986), bacteriuria may be completely asymptomatic or remain localised in the bladder without the development of renal infection. Urine secreted by normal kidney is sterile and remain so while it travels to the bladder, however, normal urine is known to have a microbial flora and any voided urine in normal persons may therefore contain thousands of bacteria per millilitre derived from this normal flora. In other to differentiate this smaller number of microorganisms from the larger number of microorganisms commonly found in infections of the urinary tract, it is essential to count the number of bacteria present in fresh properly collected specimens by appropriate methods (Schroeder, *et al.,* 1990).

In Nigeria, UTI is prevalent among men and women, but more common among women, especially during pregnancy (Eke *et al.,* 1987). Unrecognised UTI in infancy and childhood may have serious long-term effects and chronic pyelonephritis may occur in adults. However, the infection occurs in all persons regardless of sex or age with particular impact on the young and the very elderly (Rubin *et. al.,* 1986). Sexually active females are also predisposed to UTI than their male counterparts (Wiswell and Smith, 1985; Johnson *et al.,* 1995). In later life, UTI is more among men until the age of prostatic hypertrophy (above 40 years of age) (Schroeder *et al.,* 1990).

For many years, pathogens associated with uncomplicated UTI have remained constant, with *E. coli* identified as the etiological agent in about 75-90% of infections (Hooton and Stamm, 1997). Five to ten percent of uncomplicated cases are caused by *S. saprophyticus* (Gupta *et al.,* 1999) with *Klebsiella, Proteus, Enterococcus* and *Pseudomonas* species seen in much smaller percentages. (Kahlmeter, 2001; Gupta., 2001; Wright *et. al.,* 2000).

In women, signs can include unusual vaginal discharge or bleeding, burning during urination or lower abdominal pain. Men like women, may in addition to pain during urination develop swellings in the testicles. Without treatment 40% of infected women develop pelvic inflammatory disease (PID) which affects the fallopian tubes and causes damage to the ovaries (Delpiano et al. 1994). *Chlamydia trachomatis* have human as their only natural host primates may be susceptible to experimental infection (Orienston, 1998) . *Chlamydia trachomatis* causes about 40% non-gonococcal urethritis in men and occur concurrently with *Niesseria gonorrheae* in as many as 50% of the later in women. *Chlamydia trachomatis* causes muco-purulent cervicitis, urethritis, endometritis, salpingitis, perihepatitis and later post partum endometritis (Okoror, 2010). At least a third of infected females have no symptom (Orienston, 1998). Young children are particularly vulnerable to the infection. Transmission is usually by contact with formitis where it causes pharyngitis in children. Approximately 75% of neonates born by vaginal infected mothers become infected. The infection may remain latent for several months after birth (Schachter and Dawson, 1978). Less commonly infants born with caesarian sections may also be infected. The anatomic sites

most commonly infected in infants are the conjunctiva which often manifest as purulent conjunctivitis and nasopharynx. Serious manifestation of post-natal chlamydial infection is pneumonia, which may range in severity. Reports have it that the male urethral and the female cervix serves as a reservoir for *Chlamydia trachomatis* (Chernesky et al. 1994) and that if symptoms are present in the lower urinogenital genital tract they are expressed as cervicitis or urethritis. A major involvement of *Chlamydia trachomatis* in urethritis was studied by Chernesky et al. (1994b) when they tested first void urine in both males and females in Canada using the Ligase Chain reaction of which 6% females and 18.4% males were positive to *Chlamydia trachomatis.*

Age groups	Total Tested		Number Positive (%)		Total Positive
	Male	Female	Male	Female	
10-15	10	15	2 (8)	6 (24)	8 (32)
16-21	72	108	49 (27.2)	69 (38.3)	118 (65.6)
22-27	56	99	52 (35.5)	54 (34.8)	106 (68.4)
28-33	49	71	33 (27.5)	40 (33.3)	73 (60.8)
34-39	40	71	23 (20.7)	40 (36)	63 (56.8)
40-45	42	66	25 (23.1)	37 (34.3)	62 (57.4)
46-51	32	59	20 (22)	26 (28.6)	46 (50.5)
52-57	29	42	19 (26.8)	24 (33.8)	43 (60.6)
58-63	36	38	22 (29.7)	23 (31.1)	45 (60.8)
64-69	29	40	18 (26.1)	19 (27.5)	37 (53.6)
Total	**395 (39.3)**	**609 (60.7)**	**263 (43.8)**	**338 (56.2)**	**601 (59)**

Table 1. Distribution of subjects tested for multiple infection (non-specific urethritis) with bacteria associated with UTI.

This study sought to establish the involvement of *Chlamydia trachomatis* in non-specific urethritis so as to make treatment of the disease easier and quicker by knowing the likely organisms that are involved in urethritis especially when multiple organisms are involved which might make treatment and management of disease more complex.

2. Materials and methods

2.1 Sample collection

Mid urine samples (1004) were collected from both male (467) and females (537) as well as urethral swabs were from males and endocervical and high vaginal swabs from females visiting various clinics for cases of urethritis. Blood samples were also collected from all the patients. The blood samples were aseptically collected into sterile vacutaniers, centrifuged at 3000 rpm (hetituch), sera separated, collected into sterile vials and stored at -20^{o}C until used. The endocervical swab and the urethral swabs were collected into modified Ringer's solution as transport medium. Ringer's solution has been modified by the addition of calf serum and addition of vancomycin, streptomycin and nystatin. The samples were then transported to the laboratory. Clinical information of the patients sampled were collected which included pain during urination, penal and vaginal discharge, urethral and vaginal itching, foul vaginal smell and urethral irritation. Only those samples that gave a growth of more than one bacteria were further screened for *Chlamydia trachomatis.* Sample size was calculated using the online sample size calculator from sample survey network using the 2005 National Census figure available in the Nigerian Population Commission.

2.2 Procedure

The urine samples were immediately cultured onto, Nutrient agar, McConkey agar, Blood agar, Chocolate agar, Mannitol salt agar, Thayer Martins media and CLED agar plates (Oxoid). All the samples were cultured in duplicates and incubated both aerobically an anaerobically at 37^0C (Gallenkamp, UK) for 24 hours. Bacterial count and identification were done according to the standard methods of *Bergey's manual* (1997), Harrigan and McCane (1976) and Cowan and Steel (1993). Endocervical swabs and urethral swabs were cultured into the yolk sac of chicken's embryonated eggs (Krivoshein 1998). The blood samples were analysed using the complement fixation test (Okoror, 2010) using the positive culture material from embryonated eggs as antigen. The antigen was then titetrated to the required concentration. The sheep red blood cells used was obtained by bleeding the jugular vein of a sheep and then washed in Alseveir's solution. The sheep red blood cells were stored at 4^oC until used. Guinea pig serum was obtained by cardiac puncture of guinea pigs to obtain blood and the blood centrifuged to obtain the serum which was later mixed with required concentration of streptomycin and stored at 4^oC until used as complements. Sheep red blood cells was used to vaccinate rabbit for at least two weeks, the blood of the rabbit was obtained by jugular vein, centrifuged and titerated to the required concentration and used as heamolytic serum. The swabs were emulsified in sterile phosphate buffered saline before inoculating into yolk sac of 7 days old chicken's embryonated eggs as described by Krivoshein (1998). The eggs were harvested after 10 days of incubation. The eggs were candled before and after incubation prior to harvesting. Upon harvesting a portion of the harvest materials were fixed with pure ethanol on a clean grease free slide, Romanoesky-Giemsa staining technique carried out and observed for species-specific inclusion bodies under the oil immersion objectives. Statistical analysis was done using the SPSS version 17 by carrying out the regression analysis using the total positive result as the dependent variable and other individual results (CCFA, Culture into chicken's embryonated eggs and monoclonal antibody tests) as the explanatory variable.

3. Results

Of the 1004 mid stream urine samples collected from patients with symptoms of urethritis in Nigeria and tested for bacteria involved in urethritis, only 601 were positive for multiple infections with UTI organisms. This included 56 samples positive for *Pseudomonas aeruginosa* and *Staphyloccocus aureus,* 129 positive for *Proteus mirabilis, Pseudomonas aeruginosa, Staph aureus* and *E. coli.* 97 were positive for *Klebsellia* sp and *Pseudomonas* sp, 21 for *Enteroccocus* sp and *Staph aureus,* 102 for *E. coli* and *Staph aureus* while 196 were positive for *E. coli, Staph aureus, Streptoccocus* sp and *Proteus* sp. From the 601 positive for different UTI organisms, 263 (43.8%) were males while 338 (56.2%) were females. Age group distribution shows that age group 16-21 had the highest number of individuals visiting hospitals for UTI cases which was followed by 22-27 with the highest number of individuals positive to non-specific urethritis (Table 1). A total of 395 (39.3%) males and 609 (60.7%) females visitied the hospitals for UTI. The 601 positive samples for non-specific urethritis were screened for *Chlamydia* complement fixing antibody (CCFA) with 205 (34.1%) positive for males and 278 (46.3%) positive for females. Distribution of CCFA according to age group (table 2) shows that age group 22-27 had the highest positive case which was closely followed by 16-21. More females had the CCFA (272) as compared to males (227). Females also had the highest

positive individuals across the age groups with the exception of 22-27 age groups where more males had the CCFA.

Age groups	Number positive (%)		Total
	Males	Females	
10-15	2	5	7
16-21	33	56	89
22-27	50	47	97
28-33	31	46	77
34-39	30	45	75
40-45	17	30	47
46-51	16	26	38
52-57	17	24	41
58-63	17	25	42
64-69	14	14	28
Total	**227**	**272**	**541**

Table 2. Distribution of samples positive to CCFA across the age groups.

Antibody titeration shows that 66% of the subjects positive to CCFA had antibody titre higher than 1:16. Age group 16-21 had the highest number of subjects with anti body titre higher than 1:16 Culture of samples into chicken's embryonated eggs shows that 499 of the total samples positive to CCFA were positive to *Chlamydia trachomatis* specific inclusion bodies with age groups 16-21 and 22-27 having the highest positive results. Also the result from the embryonated eggs culture was 31 less than those CCFA with antibody titre of 1:16 and above. Regression analysis showed that there was no significant (t=0.111, p=0.915, -18.797-20.587; CI=99%) difference between the result obtained by culture into chicken's embryonated eggs and CCFA as well as test using the monoclonal antibodies kits (CCFA t=1.176, p=0.284, -2.756-7.854; Culture t=2.410, p=0.053, -0.122-16.282; Monoclonal antibody t=-1.921, p=0.103, -21.415-2.576; CI=99%) however, the monoclonal antibody kits varied differently while culture into chicken's embryonated eggs and CCFA varied in the same direction (table 5). ANOVA reveal a significant difference within groups of all the positive results by comparing the sum of squares (F=35.17).

Age Groups	Antibody titre								
	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	Total
10-15	-	2	2	2	1	-	-	-	7
16-21	20	20	13	11	9	10	6	-	69
22-27	31	19	42	-	-	-	5	-	66
28-33	11	29	17	5	5	5	-	5	66
34-39	21	18	13	3	10	5	5	-	54
40-45	5	5	10	11	13	1	-	2	42
46-51	3	8	8	5	5	4	4	1	35
52-57	21	9	10	10	-	-	-	-	30
58-63	5	32	3	-	1	1	-	-	37
64-69	3	3	3	1	6	6	6	-	25
Total	**120**	**145**	**121**	**48**	**50**	**32**	**26**	**9**	**431**

Table 3. Antibody titeration of sera positive to CCFA.

Age Groups	Test Performed		
	CFT	Culture	Monoclonal
10-15	7	6	7
16-21	89	80	82
22-27	97	89	91
28-33	77	66	69
34-39	75	67	71
40-45	47	47	47
46-51	38	38	38
52-57	41	38	39
58-63	42	40	40
64-69	28	28	28
Total		**499**	**501**

Table 4. Distribution of *Chlamydia* in different test performed (CFT, Culture and Monoclonal antibodies).

4. Discussion

Infection of the genital with *Chlamydia trachomatis* cannot be overemphasized. Reports have it that the organism has been involved in both female and male urinogenital infection with the females worse hit in both mild and chronic infections [Okoror et al 2008). *Chlamydia trachomatis* have also been reported to cause about 40% non-gonoccocal urethritis and occur concurrently with about 25% cases with *Niesseria gonorrheae* with sparse report of *Chlamydia trachomatis* in non-specific urethritis especially in developing countries where *Chlamydia trachomatis* is not currently been screened for in the day to day clinical diagnosis (Okoror, 2010). Reports also has it that relative frequency of *Chlamydia trachomatis* infections in developing countries is sparse and that infections could be higher than have been reported which is largely due to lack of diagnosis for *Chlamydia trachomatis* in developing countries which justifies this study. The lack of information on relative frequencies of *Chlamydia trachomatis* infection have let to lack of diagnosis in routine clinical diagnosis and therefore difficulty in treatment of *Chlamydia trachomatis* diseases like urethritis. This study is particularly concerned with the involvement of *Chlamydia trachomatis* in non-specific urethritis.

The lack of treatment of *Chlamydia trachomatis* infections may be the reason why there was a high positive result for *Chlamydia trachomatis* in this study (59.9%) which is similar to earlier reports but the percentage positivity was far higher than an earlier report by Chernesky et al. (1994) This could be because Chernesky et al. (1994) carried out their study in Canada a developed country with routine clinical diagnosis for *Chlamydia* as opposed to this study in Nigeria where there is no routine clinical diagnosis for *Chlamydia* and hence no opportunity for treatment of the infection except the infection has come up with serious sequelae. Other bacteria involved in UTI were identified in order to establish the fact that infection were actually caused by multiple organism. De Jongh et al. (2009) screened 253 males with urethritis using PCR for *Chlamydia trachomatis, Neisseria gonorrheae* and *Trichomonas vaginalis* where they reported 15% positive samples for *Chlamydia trachomatis* and 7.5% co-infection with *Neisseria gonorrheae* in South African males a result similar with the one observed in this study though with a higher positive result which is also a reflection of lack of screening for *Chlamydia trachomatis* and most probably because they screened only males. Complement

fixation test though cumbersome and not very specific for *Chlamydia trachomatis* because of the group reactive antigen of *Chlamydia* spp still remains one of the most reliable serological tests (Okoror, 2010). However, the use of culture into embryonated eggs for examination of species-specific *Chlamydia* inclusion bodies helped to distinguish *Chlamydia trachomatis* form other *Chlamydia* spp that may have a cross-reaction with *Chlamydia trachomatis*. To further act as quality control, *Chlamydia trachomatis* monoclonal antibody spot test immunochromatographic kits were used to further enhance or validated the results confirmed with the culture into chicken's embryonated eggs especially to take care of human error while observing for *Chlamydia trachomatis* inclusion bodies. Reports also have it that a titre of ≤1:16 are diagnostic. Though convalescence sera might affect the result of CFT which is why a combination of other tests was involved in this study with the CFT being the primary test. The difference in the results from culture in chicken's embryonated eggs and that of complement fixation test as well as the spot test kit may be as a result of the fact that since CFT measures antibodies, infected individuals are detected even while still convalescing. Since both CFT and the spot test kit measure antibodies, there could be possibilities of an individual shedding the organism at convalescent stage without having the disease. The fact that CFT captures antibodies in convalescent stage of infection may be the reason while the culture result is lower than that of the CCFA, although the difference is insignificant (t=0.111, p=0.915, -18.797-20.587; CI=99%) (Table 6) statistically. The result from the monoclonal antibody test kit varies in the opposite direction as compared with that of the culture and CCFA is suggestive of the more sensitivity of the monoclonal antibody test kit and then justifies its use as confirmatory test. The significant difference within the age groups shows that though *Chlamydia trachomatis* UTI is more in the sexual active age of the adolescents and though the older ages may have the infection significantly, may have contacted the infection in their adolescent age since the organism is found of latent infection. Adults involved in indiscriminate sexual activities may also have contacted UTI which involved *Chlamydia trachomatis* which also accounts to why a high percentage of adults were positive to *Chlamydia trachomatis* UTI and also other organisms involved in non-specific urethritis.

Model			Mono	CFT	Culture
1	Correlations	Mono	1.000	-.823	-.907
		CFT	-.823	1.000	.508
		Culture	-.907	.508	1.000
	Covariances	Mono	24.033	-8.743	-14.912
		CFT	-8.743	4.700	3.695
		Culture	-14.912	3.695	11.235

[a]Dependent Variable: Total positive
Key: Mono=Monoclonal antibody test

Table 5. Coefficient correlations[a].

Age is a factor to UTI especially as it involves the early age groups with lesser number as well as lower percentage of individuals with UTI and also non-specific urethritis involving *Chlamydia trachomatis* as most individuals in this age group are not yet sexually active. The

high percentage of females which is significantly different from those of their male counterparts both in the UTI generally, as well as multiple infection with *Chlamydia trachomatis* is not unconnected with the short urethral of the female genital organ which makes them more prone to UTI both in unhygienic environment as well as sexually as earlier reported. This study, however establish the fact that *Chlamydia trachomatis* is highly involved in UTI at the same time with other organisms. This makes treatment of UTI difficult especially in developing countries where *Chlamydia trachomatis* is not screened for in cases of UTI and hence the infection remains to lead to more serious sequelae.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	P			Lower Bound	Upper Bound
(Constant)	.895	8.048		.111	.915	-18.797	20.587
CFT	2.549	2.168	2.245	1.176	.284	-2.756	7.854
Culture	8.080	3.352	6.228	2.410	.053	-.122	16.282
Mono	-9.420	4.902	-7.518	-1.921	.103	-21.415	2.576

Key: Mono=Monoclonal antibody test

Table 6. Statistical coefficients.

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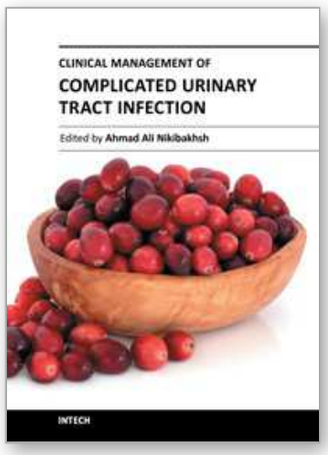

Clinical Management of Complicated Urinary Tract Infection
Edited by Dr. Ahmad Nikibakhsh

ISBN 978-953-307-393-4
Hard cover, 294 pages
Publisher InTech
Published online 06, September, 2011
Published in print edition September, 2011

Complicated urinary tract infections (cUTIs) are a major cause of hospital admissions and are associated with significant morbidity and health care costs. Knowledge of baseline risk of urinary tract infection can help clinicians make informed diagnostic and therapeutic decisions. Prevalence rates of UTI vary by age, gender, race, and other predisposing risk factors. In this regard, this book provides comprehensive information on etiology, epidemiology, immunology, pathology, pathogenic mechanisms, symptomatology, investigation and management of urinary tract infection. Chapters cover common problems in urinary tract infection and put emphasis on the importance of making a correct clinical decision and choosing the appropriate therapeutic approach. Topics are organized to address all of the major complicated conditions frequently seen in urinary tract infection. The authors have paid particular attention to urological problems like the outcome of patients with vesicoureteric reflux, the factors affecting renal scarring, obstructive uropathy, voiding dysfunction and catheter associated problems. This book will be indispensable for all professionals involved in the medical care of patients with urinary tract infection.

How to reference
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Okoror Lawrence (2011). Chlamydia Trachomatis in Non-Specific Urethritis, Clinical Management of Complicated Urinary Tract Infection, Dr. Ahmad Nikibakhsh (Ed.), ISBN: 978-953-307-393-4, InTech, Available from: http://www.intechopen.com/books/clinical-management-of-complicated-urinary-tract-infection/chlamydia-trachomatis-in-non-specific-urethritis

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