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article

Incidence of recurrent diagnoses of *Chlamydia trachomatis* genital infections among male and female soldiers of the US army

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Background/objectives: Few studies of *Chlamydia trachomatis* incidence, especially among men, and most studies of *C trachomatis* in US military populations are cross sectional prevalence surveys. A population based retrospective cohort was used to determine risk factors for repeat diagnoses of genital *C trachomatis* infections among male and female soldiers with previous *C trachomatis* infections.

Methods: All active duty soldiers diagnosed with *C trachomatis* genital infections between 1994 and 1998. Cohort members were passively followed until repeat diagnoses of *C trachomatis* infection, termination of army service, or the end of the study.

Results: Among 11 771 soldiers with initial diagnoses of chlamydia, the crude rate of repeat diagnoses was 52.0 per 1000 person years. Women and men aged 20–24 were at greatest unadjusted risk of reinfection. After adjustment, women aged 20–24 and men aged 25–29 were at higher risk than their younger or older counterparts.

Conclusions: Results of this study suggest that both male and female soldiers who are diagnosed with chlamydia infections have relatively high risks of reinfection through their 20s.

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Keywords: epidemiology; military personnel; sexually transmitted diseases; United States

Introduction

Chlamydia trachomatis is the most common bacterial cause of sexually transmitted diseases in the United States.^{1–4} In the United States in 1997, it was estimated that 335.8 and 70.4 per 100 000 women and men, respectively, were infected with chlamydia.^{1,5} While more than half of a million cases were reported in 1997, it was estimated that nearly five times as many cases were asymptomatic and undetected.^{1,2} Thus, the annual incidence of new chlamydia infections in the United States is approximately three million.^{2–4} Costs associated with genital *C trachomatis* infections (for example, urethritis, cervicitis, epididymitis, salpingitis, pelvic inflammatory disease (PID), infertility, neonatal conjunctivitis, and pneumonia) are estimated to exceed \$2 billion annually.³

Chlamydia studies in US military populations have generally focused on infection prevalences in selected subgroups. For example, Brodine and colleagues studied asymptomatic active duty members of the US navy and marines. Infections were detected in 4.1% and 4.5% of male and female survey participants, respectively.⁶ Gaydos and colleagues documented chlamydia infections in 9.2% of new female recruits at a large US army basic training post.⁷ Catterson and Zadoo documented chlamydia infections in 8.2% of 476 asymptomatic female soldiers who presented to a troop medical clinic for routine Papanicolaou smears.⁸

The Armed Forces Epidemiological Board recommends all new female accessions undergo chlamydia screening, preferably within the recruit training period but screening within

the first year is acceptable. Existing female military service members should be screened routinely for chlamydia at the time of each recommended Papanicolaou smear until age 25, with further screening to be dictated by symptoms or risk factors. Chlamydia screening for male personnel is recommended at any medical encounter as indicated by symptoms or risk factors.

While prevalence surveys are useful for characterising the burden of *C trachomatis* infections in surveyed subgroups, they are not informative regarding the dynamics of its spread (that is, rates of and risk factors for acquiring new infections). There have been few studies, however, and none in US military populations, that have documented incident (as opposed to prevalent) chlamydia infection rates and risk factors. For this study, a cohort of active duty soldiers who were previously diagnosed with (and presumably effectively treated for) *C trachomatis* infections were passively followed to assess incidence rates of and correlates of risk of repeat *C trachomatis* diagnoses.

Methods

DATA SOURCES

The Defense Medical Surveillance System (DMSS) is the central resource of the US Department of Defense for medical surveillance of active duty service members. The DMSS is operated by the Army Medical Surveillance Activity. On a regular basis, the DMSS receives, validates, and integrates in a relational database system personnel, hospitalisation, ambulatory visit, and reportable events data relevant to all active members of the US

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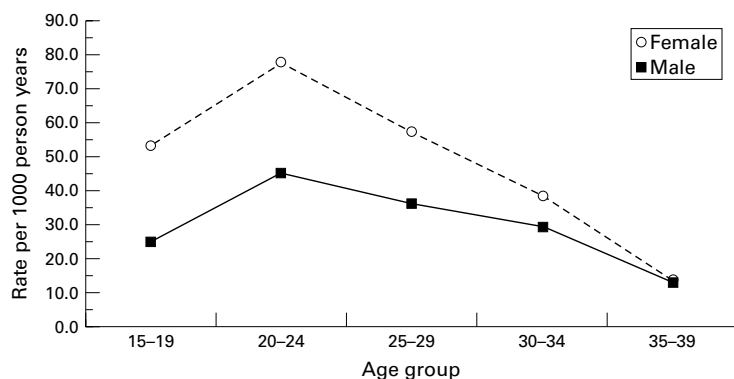


Figure 1 Age and sex specific rates of repeat diagnoses of *C trachomatis* infections, US Army.

armed services. On a monthly basis, files that list all individuals on active duty (including demographic and military characteristics of each individual) are transmitted from the Defense Manpower Data Center, Seaside, California, to the DMSS. Also, since 1994, there has been an armywide requirement to report all cases of approximately 70 medical conditions (based on their public health, political, and/or military operational importance) to the Army Medical Surveillance Activity for inclusion in the DMSS. *C trachomatis* genital infections are among the army's required reportable medical events.

STUDY DESIGN

The study was a passive retrospective follow up of a cohort of active duty US army soldiers. Active duty soldiers were passively entered into a study cohort on the 30th day after the first report of a laboratory confirmed (Transcription Mediated Amplification, Gen-Probe, San Diego, CA, USA) *C trachomatis* genital infection (ICD-9-CM "099.41") during the period 1 January 1994 to 31 December 1998. Cohort members were tested for *C trachomatis* as a

Table 1 Frequencies and incidence rates of repeat diagnoses of genital *C trachomatis* infections during follow up of a cohort of previously infected US army soldiers, 1994–July 1999

	Incident cases (%)	Person years of follow up	Repeat diagnoses (per 1000 person years)	Rate ratio (RR) (95% CI)
Overall	879	16903.26	52.00	—
Sex				
Female	557 (63.4)	8466.44	65.79	1.72 (1.50–1.98)
Male	322 (36.6)	8436.81	38.17	1.00
Age*				
<20	134 (15.2)	3023.29	44.32	3.50 (1.54–7.93)
20–24	557 (63.4)	9002.21	61.87	4.89 (2.19–10.92)
25–29	146 (16.6)	3285.18	44.44	3.51 (1.55–7.94)
30–34	36 (4.1)	1118.82	32.18	2.54 (1.07–6.03)
35+	6 (0.7)	473.75	12.66	1.00
Race				
Black	558 (63.5)	9831.40	56.76	1.17 (0.92–1.47)
White	240 (27.3)	5406.42	44.39	0.91 (0.71–1.17)
Other	81 (9.2)	1665.43	48.64	1.00
Marital status				
Married	234 (26.7)	5631.84	41.55	0.87 (0.62–1.23)
Single	607 (69.1)	10474.08	57.95	1.22 (0.88–1.69)
Other	38 (4.3)	797.34	47.66	1.00
Military rank (grade)†				
PVT (E1–E2)	152 (17.3)	3969.69	38.29	1.27 (1.00–1.62)
PFC–CPL (E3–E4)	613 (69.7)	9147.45	67.01	2.22 (1.82–2.72)
SGT–LTC (E5–O5)	114 (12.9)	3784.52	30.12	1.00

*Mean ages: women = 22.46 years, men = 23.77 years.

†Grades E1–E4 approx \$11 520 to \$17 820; grades E5–O4, \$18 168 to \$40 716 per annum (1998 US\$).

result of symptoms, part of a routine gynaecological examination, or named a potential infectious contact. Each member of the cohort was passively followed from the time of entry in the cohort until (a) a study end point; (b) death, retirement, or discharge from military service before the end of the study (a censoring event); or (c) the end of the study (a censoring event). End points were defined as the first reports of *C trachomatis* infections of cohort members during follow up. The end of the study was 15 July 1999.

Exposure to risk was quantified in terms of person time of follow up. Person time was calculated as the time from enrolment in the follow up cohort until an end point or censoring event. Incidence rates were calculated by dividing the number of end points per stratum by the appropriate stratum specific person time estimates.

Cox proportional hazards models were used to calculate hazard ratios (HR) and 95% confidence intervals (CI) while controlling for effects of potentially confounding factors. Variables considered in both unadjusted and adjusted models were age, race, marital status, and military rank (at the time of entry in the cohort). All analyses were carried out using SAS (Ver 6.12, Carey, NC, USA).

Results

CHARACTERISTICS OF THE FOLLOW UP COHORT

Between 1 January 1994 and 31 December 1998, 12 800 cases of *C trachomatis* were reported among 11 771 active duty soldiers. Because repeat diagnoses within a 30 day period were considered to be recurring infections, 1193 repeat diagnoses among 1057 active duty personnel were excluded. The experience of these soldiers following presumably effective treatments of their *C trachomatis* infections formed the study base. Approximately half (49.6%) of the cohort's members were males. Soldiers who were black non-Hispanic (56.3%), never married (65.7%), or high school graduates or less (95.2%) were also overrepresented among cohort members in relation to the army overall. The median ages of cohort members (at the time of their first reported *C trachomatis* infections) were 21.5 years (range 16.6–50.9) and 22.9 years (range 17.1–48.8) for females and males, respectively. Ninety one per cent of all cohort members were based in the continental United States; 68% of those were in the southern United States (Alabama, Arkansas, Delaware, Washington DC, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia).

RECURRENCE INCIDENCE RATES

A total of 879 cohort members had repeat diagnoses of genital *C trachomatis* infections during variable periods of follow up. The cumulative incidence of repeat diagnoses during follow up was 7.5%, and the crude rate of repeat diagnoses was 52.00 per 1000 person years. Crude rates of repeat diagnoses were higher among females than males in all age

Table 2 Risk factors and 95% CI for repeat diagnoses of *C trachomatis* infections among active duty US army personnel, 1994–July 1999

	Female				Male			
	Unadjusted HR*	95% CI	Adjusted† HR	95% CI	Unadjusted HR	95% CI	Adjusted† HR	95% CI
Age group								
30+	1.00	—	1.00	—	1.00	—	1.00	—
25–29	1.73	1.02–2.93	1.49	0.89–2.57	1.50	0.95–2.36	1.22	0.76–1.97
20–24	2.35	1.44–3.82	1.79	1.04–3.08	1.77	1.16–2.68	1.07	0.64–1.79
<20	1.56	0.94–2.60	1.16	0.65–2.07	1.00	0.95–2.36	0.54	0.28–1.03
Race								
White	1.00	—	1.00	—	1.00	—	1.00	—
Black	1.10	0.93–1.30	1.13	0.94–1.32	1.75	1.38–2.22	1.82	1.43–2.31
Marital status								
Married	1.00	—	1.00	—	1.00	—	1.00	—
Single	1.10	0.92–1.31	1.05	0.86–1.27	1.53	1.21–1.94	1.49	1.13–1.96
Military rank‡								
SGT-MAJ (E5–O4)	1.00	—	1.00	—	1.00	—	1.00	—
PVT-CPL (E1–E4)	1.66	1.24–2.24	1.47	1.04–3.08	1.57	1.20–2.06	1.51	1.06–2.14

*HR = hazard ratio, CI = confidence interval.

†After adjustment for all other terms in table.

‡Grades E1–E4 approx \$11 520 to \$17 820; grades E5–O4, \$18 168 to \$40 716 per annum (1998 US\$).

categories (fig 1). Among both males and females, crude rates peaked in the early 20s (females: 77.98 per 1000 person years; males: 45.30 per 1000 person years) and declined with age thereafter. Single and black cohort members had higher crude rates of repeat diagnoses than their counterparts (table 1). One hundred and thirty personnel were diagnosed with at least two repeat genital *C trachomatis* infections.

SURVIVAL ANALYSIS

Among female cohort members, the strongest independent predictors of repeat diagnosis risk were age and grade. With control of effects of other factors, females in their 20s had higher risks of repeat diagnosis than those younger or older. Females in their early 20s (the highest risk age group) were 79% more likely to have repeat *C trachomatis* diagnoses than those older than 30 (the lowest risk age group) (table 2). Other than age, the strongest independent correlate of repeat diagnosis among females was junior enlisted grade ($RR_{adj}=1.66$, versus senior enlisted or officer). Of note, marital status and race were not significant correlates of repeat diagnosis among females.

Among male cohort members, repeat diagnosis risks increased with age through the 20s and declined with age thereafter. Males in their late 20s (the highest risk age group) were more than twice ($RR_{adj}=2.26$) as likely as teenagers (the lowest risk age group) to have repeat *C trachomatis* diagnoses. Other than age, the strongest independent correlates of repeat diagnoses among males were black race ($RR_{adj}=1.82$, versus white), single marital status ($RR_{adj}=1.49$, versus married), and junior enlisted grade ($RR_{adj}=1.51$, versus senior enlisted or officer) (table 2).

Discussion

Throughout history, sexually transmitted infections (STIs) have caused significant morbidity among soldiers.^{9–10} It is difficult, however, to characterise risk factors for acquiring STIs during military service since prevalent infections may be asymptomatic and thus undetected for long periods. In addition, the US

military services receive recruits from every geographic region of the United States and from a broad spectrum of sociodemographic backgrounds, and while on active duty, service members are stationed at or temporarily deployed to numerous locations around the world. Thus, when infections are diagnosed, the times, locations, and circumstances of their acquisitions are often indeterminable. Since many prevalent infections were acquired before service or at unknown times during service, incidence data are necessary to assess rates of and to characterise risk factors for acquiring genital chlamydia infections among soldiers.

The objectives of the study were to estimate rates and demographic correlates of risk of recurrent *C trachomatis* infections among active duty US army soldiers. We initiated follow ups of previously infected cohort members 30 days after their initial diagnoses to allow for full treatment effects, appropriate follow ups, and retreatments if necessary. Although an assumption of cure 30 days after initial diagnoses may have been justified based on the universal availability of cost free medical care, the ease of delivery of effective treatments, and the generally aggressive management of STIs by military medical staffs, we refer to end points of the study as “repeat diagnoses” rather than as “recurrent infections.”

Studies among females have generally found that *C trachomatis* prevalences and reinfection risks were highest among teenagers and declined with age thereafter.^{7–11–14} In addition, a recent large cross sectional survey of female army recruits found that black race was a significant predictor of prevalent *C trachomatis* infection.⁷ In contrast, in this study, females in their 20s had higher risks of repeat diagnoses than those in their teens, and race was not a strong risk correlate. Many factors could account for these differences. For example, this study was population rather than STD clinic based. In general, teenaged females who are treated at STD clinics in large urban areas, for example, may not be comparable with teenagers in active military service. In addition, when some young females enter military service, they may move from relatively high (for example,

hyperendemic “core” neighbourhoods) to lower STI risk circumstances.¹⁵ Finally, females in the army may be more responsive to STI counselling and prevention.

There have been remarkably few studies of chlamydia genital infection incidence among men. In this study in which nearly half of the subjects were men, male soldiers who were single, black, and in their late 20s had increased risks of repeat diagnoses relative to their counterparts. Recent cross sectional surveys among females in military service led to the recommendation that recruits younger than 25 years old should be routinely screened. Findings of the current study suggest that since soldiers have relatively high rates of recurrent infections through their 20s, as a minimum, there should be counselling and follow up testing of all men and women (regardless of age) after documented chlamydia infections.

Results of the study should be interpreted carefully. For example, the study followed only soldiers with initial diagnoses of *C trachomatis* infections. As a result, findings from follow up of this relatively “high risk” cohort may not be generalisable to other military service members. Also, it is unlikely that all initial infections were eradicated by treatment.¹⁶ As a result, some persistent “initial” infections were probably included among “repeat” diagnoses. In addition, study end points were ascertained from notifiable medical event case reports (which are less than 100% sensitive) and censoring occurred without active assessments of *C trachomatis* infection status. As a result, there was undoubtedly underascertainment of end points among cohort members. Finally, screening and diagnostic tests for genital *C trachomatis* infections vary widely in their operating characteristics.¹⁷ As a result, in this study, some true infections were undoubtedly “missed” owing to relatively insensitive test modalities, materials, and/or procedures. In consideration of the study’s characteristics overall, we believe that point estimates of rates of repeat diagnoses from the study should be considered *lower bound* estimates of actual recurrent infection rates.

Relative risk estimates derived from the study should also be interpreted cautiously. To control for possible sex related differences in end point ascertainment (for example, clinical manifestations of genital infections, routine screening practices), analyses were conducted separately among males and females. In relation to military rank, there are perceived incentives for senior enlisted soldiers and officers to seek care of STIs outside of the military medical system. Since the study was restricted to soldiers who were the subjects of recent chlamydia case reports, it seems likely that most if not all repeat diagnoses would also be reported. Still, relative risks associated with junior enlisted grade may be overestimated due to more complete ascertainment and reporting

of their infections. Finally, since medical care is free and accessible to all soldiers regardless of age, race/ethnicity, and marital status, the directions and magnitudes of risks associated with these factors seem likely to be valid.

In conclusion, this study is the first to attempt to estimate *C trachomatis* infection rates and risk factors in a population of US military service members, and it is one of only a few studies to include significant numbers of males. Results of the study suggest that both male and female soldiers have relatively high risks of recurrent chlamydia infections through their 20s. The findings extend insights gained from cross sectional surveys in military populations. They should be considered during the development and implementation of military screening, treatment, and prevention practices.

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